

OPERATING INSTRUCTIONS

LD-MRS

3D LiDAR sensor



Described product

LD-MRS

- LD-MRS400001 (standard version)
- LD-MRS400102 (heavy-duty version)
- LD-MRS420201 (UAV version with lightweight housing)
- LD-MRS800001 (standard version with 8 levels)
- LD-MRS820301 (lite version with 8 levels)

Manufacturer

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Original document

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1 About this document

1.1 Information on the operating instructions

These operating instructions provide important information on how to use devices from SICK AG.

Prerequisites for safe work are:

- Compliance with all safety notes and handling instructions supplied.
- Compliance with local work safety regulations and general safety regulations for device applications

The operating instructions are intended to be used by qualified personnel and electrical specialists.

NOTE

Read these operating instructions carefully to familiarize yourself with the device and its functions before commencing any work.

The operating instructions are an integral part of the product. Store the instructions in the immediate vicinity of the device so they remain accessible to staff at all times. Should the device be passed on to a third party, these operating instructions should be handed over with it.

These operating instructions do not provide information on the handling and safe operation of the machine or system in which the device is integrated. Information on this can be found in the operating instructions for the machine or system.

1.2 Explanation of symbols

Warnings and important information in this document are labeled with symbols. Signal words introduce the instructions and indicate the extent of the hazard. To avoid accidents, damage, and personal injury, always comply with the instructions and act carefully.



DANGER

... indicates a situation of imminent danger, which will lead to a fatality or serious injuries if not prevented.



WARNING

... indicates a potentially dangerous situation, which may lead to a fatality or serious injuries if not prevented.



CAUTION

... indicates a potentially dangerous situation, which may lead to minor/slight injuries if not prevented.



NOTICE

... indicates a potentially harmful situation, which may lead to material damage if not prevented.



NOTE

... highlights useful tips and recommendations as well as information for efficient and trouble-free operation.

1.3 Further information

More information can be found on the product page.

The page can be accessed via the **SICK Product ID:** pid.sick.com/{P/N}/{S/N}

{P/N} corresponds to the part number of the product, see type label.

{S/N} corresponds to the serial number of the product, see type label (if indicated).

The following information is available depending on the product:

- Data sheets
- This document in all available language versions
- CAD files and dimensional drawings
- Certificates (e.g., declaration of conformity)
- Other publications
- Software
- Accessories

2 Safety information

2.1 Intended use

The LD-MRS is a non-contact multi-plane LiDAR sensor for industrial use, especially outdoors.

As an intelligent sensor based on time-of-flight technology, it scans its surroundings horizontally by rotating laser beams in up to 8 scan planes vertically, one above the other. It offers a radial field of view with an aperture angle of 85° for up to 8 scan planes. The field of view can be extended to a total of 110°, the LD-MRS uses 2 or 4 of the 4 or 8 scan planes for the additional part of the area. Using the scan planes, the LD-MRS records the distance and position of the objects to itself (measurement origin) as an ambient profile.

Using its Ethernet interface, the LD-MRS continuously outputs the calculated data of the scans as raw data on request for processing in a software application.

In addition, the LD-MRS can monitor up to 16 freely definable detection fields (areas). It signals violations of individual fields, also when combined as part of a logical evaluation strategy, in definable evaluation cases via max. 10 external switching outputs. These are achieved with the help of max. 2 CAN modules (accessories).

The LD-MRS enables two applications with its radial field of view:

- Detection of objects around the position or assembly site with continuous output of measurement data as requested
- Field monitoring of freely defined areas with signaling of object detections via external switching outputs

The LD-MRS detects objects in the field of view.

The following fields of application are possible:

- Container loading/handling
- Traffic/Transport
- Robotics/UAV
- Collision protection
- Autonomous vehicles in surface mining
- Safety monitoring
- Topography and urban surveying

The LD-MRS 3D LiDAR sensor is intended for use in industrial environments only. Radio interference may arise when used in residential areas.

In measuring mode, the determined measurement data can be used by an external processing function for the determination and examination of objects. In field monitoring, external switching outputs signal the change of monitored areas (fields). For this purpose, evaluation cases with application-specific evaluation strategies can be defined per detection field, assigned to the switching outputs and also combined. Combinatorics of two switching inputs activates a certain evaluation case only if required.

The object tracking provides pre-processed object data. Up to 64 objects can be processed in parallel in the device. Dynamic parameters such as direction, speed and even acceleration are available for each object. This data is available when vehicle data (ego motion data) is provided.

SICK AG assumes no liability for losses or damage arising from the use of the product, either directly or indirectly. This applies in particular to use of the product that does not conform to its intended purpose and is not described in this documentation.

2.2 Improper use

Any use outside of the stated areas, in particular use outside of the technical specifications and the requirements for intended use, will be deemed to be incorrect use.

- The device does not constitute a safety component in accordance with the respective applicable safety standards for machines.
- The device must not be used in explosion-hazardous areas, in corrosive environments or under extreme environmental conditions.
- Any use of accessories not specifically approved by SICK AG is at your own risk.



WARNING

Danger due to improper use!

Any improper use can result in dangerous situations.

Therefore, observe the following information:

- Product should be used only in accordance with its intended use.
- All information in the documentation must be strictly observed.
- Shut down the product immediately in case of damage.

2.3 Cybersecurity

Overview

To protect against cybersecurity threats, it is necessary to continuously monitor and maintain a comprehensive cybersecurity concept. A suitable concept consists of organizational, technical, procedural, electronic, and physical levels of defense and considers suitable measures for different types of risks. The measures implemented in this product can only support protection against cybersecurity threats if the product is used as part of such a concept.

You will find further information at www.sick.com/psirt, e.g.:

- General information on cybersecurity
- Contact option for reporting vulnerabilities
- Information on known vulnerabilities (security advisories)

2.4 Limitation of liability

Relevant standards and regulations, the latest technological developments, and our many years of knowledge and experience have all been taken into account when compiling the data and information contained in these operating instructions. The manufacturer accepts no liability for damage caused by:

- Non-adherence to the product documentation (e.g., operating instructions)
- Incorrect use
- Use of untrained staff
- Unauthorized conversions or repair
- Technical modifications
- Use of unauthorized spare parts, consumables, and accessories

2.5 Modifications and conversions



NOTICE

Modifications and conversions to the device may result in unforeseeable dangers.

Interrupting or modifying the device or SICK software will invalidate any warranty claims against SICK AG. This applies in particular to opening the housing, even as part of mounting and electrical installation.

2.6 Requirements for skilled persons and operating personnel



WARNING

Risk of injury due to insufficient training.

Improper handling of the device may result in considerable personal injury and material damage.

- All work must only ever be carried out by the stipulated persons.

The following qualifications are required for various activities:

Table 1: Activities and technical requirements

Activities	Qualification
Mounting, maintenance	<ul style="list-style-type: none"> ▪ Basic practical technical training ▪ Knowledge of the current safety regulations in the workplace
Electrical installation, device replacement	<ul style="list-style-type: none"> ▪ Practical electrical training ▪ Knowledge of current electrical safety regulations ▪ Knowledge of the operation and control of the devices in their particular application
Commissioning, configuration	<ul style="list-style-type: none"> ▪ Basic knowledge of the computer operating system used ▪ Basic knowledge of the design and setup of the described connections and interfaces ▪ Basic knowledge of data transmission
Operation of the device for the particular application	<ul style="list-style-type: none"> ▪ Knowledge of the operation and control of the devices in their particular application ▪ Knowledge of the software and hardware environment for the particular application

2.7 Operational safety and specific hazards

Please observe the safety notes and the warnings listed here and in other sections of this product documentation to reduce the possibility of risks to health and avoid dangerous situations.



CAUTION

Optical radiation: Class 1 Laser Product

The accessible radiation does not pose a danger when viewed directly for up to 100 seconds. It may pose a danger to the eyes and skin in the event of incorrect use.

- Do not open the housing. Opening the housing may increase the level of risk.
- Current national regulations regarding laser protection must be observed.

Caution – Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.

It is not possible to entirely rule out temporary disorienting optical effects, particularly in conditions of dim lighting. Disorienting optical effects may come in the form of dazzle, flash blindness, afterimages, photosensitive epilepsy, or impairment of color vision, for example.



WARNING

Electrical voltage!

Electrical voltage can cause severe injury or death.

- Work on electrical systems must only be performed by qualified electricians.
 - The power supply must be disconnected when attaching and detaching electrical connections.
 - The product must only be connected to a voltage supply as set out in the requirements in the operating instructions.
 - National and regional regulations must be complied with.
 - Safety requirements relating to work on electrical systems must be complied with.
-



WARNING

Risk of injury and damage caused by potential equalization currents!

Improper grounding can lead to dangerous equipotential bonding currents, which may in turn lead to dangerous voltages on metallic surfaces, such as the housing. Electrical voltage can cause severe injury or death.

- Work on electrical systems must only be performed by qualified electricians.
 - Follow the notes in the operating instructions.
 - Install the grounding for the product and the system in accordance with national and regional regulations.
-

3 Product description

3.1 Scope of delivery

The delivery of the device includes the following components:

Table 2: Scope of delivery

Item	Component	Comments
1	Device in the version ordered	Depending on version Without connecting cables and brackets
1	Set of protective caps for electrical connections	Attached to the connections
1	Printed safety notes, multilingual	Quick guide and general safety notes

3.2 Type label

The type label gives information for identification of the device.



Figure 1: LD-MRS type label (example)

- ① Conformity mark/certification mark
- ② Voltage supply, typical power, max. power, operating temperature, enclosure rating
- ③ MAC address
- ④ Manufacturer
- ⑤ Production location, note: Do not remove type label
- ⑥ Production date
- ⑦ Part number
- ⑧ Serial number
- ⑨ Data Matrix code with product data and link to product page
- ⑩ Type code

3.3 Principle of operation

3.3.1 Measurement principle

The device is an optoelectronic LiDAR sensor that contactlessly scans the outline of its surroundings with the help of laser beams. The device measures its surroundings in two-dimensional polar coordinates, relative to its measurement origin. This is marked by a circular indentation in the center of the optics cover. If a laser beam strikes an object, the position of that object is determined in terms of distance and angle.

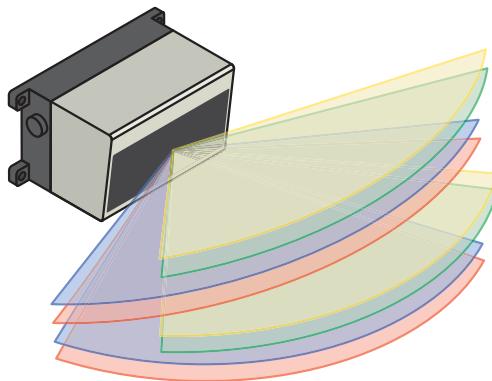


Figure 2: LiDAR sensor with 8 scan layers

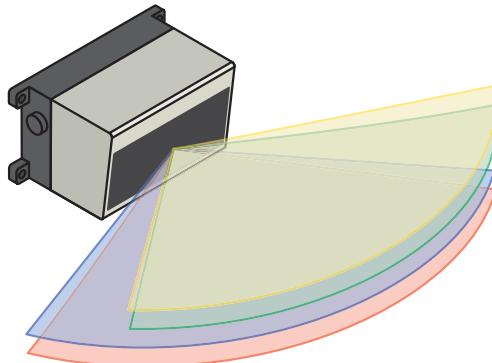
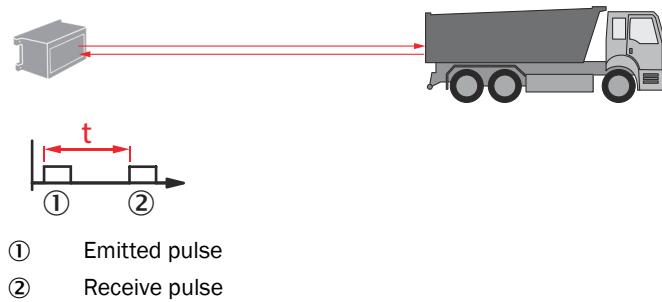


Figure 3: LiDAR sensor with 4 scan layers

3.3.2 Distance measurement

The device emits beams pulsed by a laser diode. If the laser beam is reflected by an object, the reflected beam is received by the sensor.

The distance to the object is calculated on the basis of the time that the pulsed light beam requires to be reflected and received by the sensor.



3.3.3 Impact of object surfaces on the measurement

Reflection

Most surfaces produce a diffuse reflection of the laser beam in all directions. The structure (smooth or rough), shape (flat or curved), and color (light or dark) of the surface determine how well the laser beam is reflected.

On very rough surfaces, a large proportion of the energy is lost due to absorption. Curved surfaces produce a higher diffusion. Dark surfaces reflect the laser beam worse than light ones (brilliant white plaster reflects approx. 100% of the light, while black

foam rubber reflects approx. 2.4%). The aforementioned surface characteristics can reduce the scanning range of the device, in particular for surfaces with low remission values.

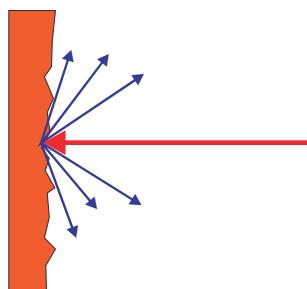


Figure 4: Reflection of light on the surface of the object

Angle of reflection

The angle of reflection corresponds to the angle of incidence. If the laser beam hits a surface at right angles, the energy is optimally reflected. If the laser beam hits a surface at an oblique angle, energy and range are lost accordingly.

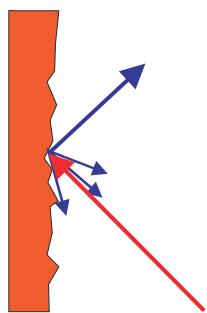


Figure 5: Angle of reflection

Retroreflection

If the reflective energy is greater than 100%, the beam is not reflected diffusely in all directions; instead it is reflected in a targeted way (retroreflection). Thus a large part of the emitted energy can be received by the laser distance measurer. Plastic reflectors (cat's eyes), reflective tape, and triple prisms have these properties.

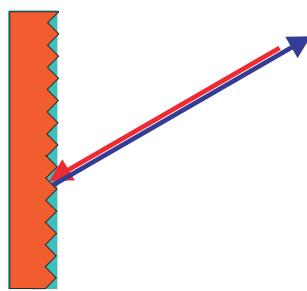


Figure 6: Retroreflection

Reflective surfaces

The laser beam is almost completely deflected on reflective surfaces. This means that an object hit by the deflected beam may be detected instead of the reflective surface.

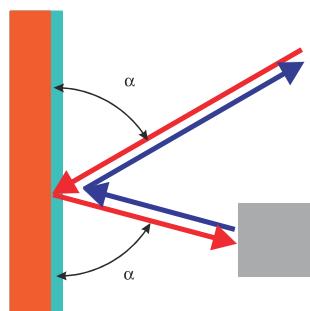


Figure 7: Specular surfaces

Small objects

Objects that are smaller than the diameter of the laser beam cannot reflect the laser light's full energy. The portion of the light beam that does not reach the object is lost. If all of the light reflected to the sensor is insufficient, the object may not be detected.

The portion of the light that does not reach the front object can be reflected by a larger object in the background. If all of the light reflected to the sensor is sufficient, this object is detected. This can lead to a corruption of the measured value.

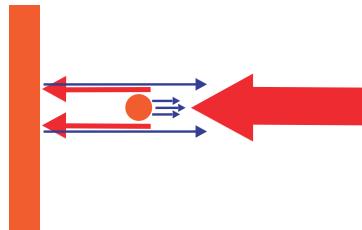


Figure 8: Object smaller than the laser beam diameter

3.3.4 Scanning range

The scanning range of the device depends on the remission of the object to be detected. The better a surface reflects the incident beam back to the device, the greater the scanning range of the device.

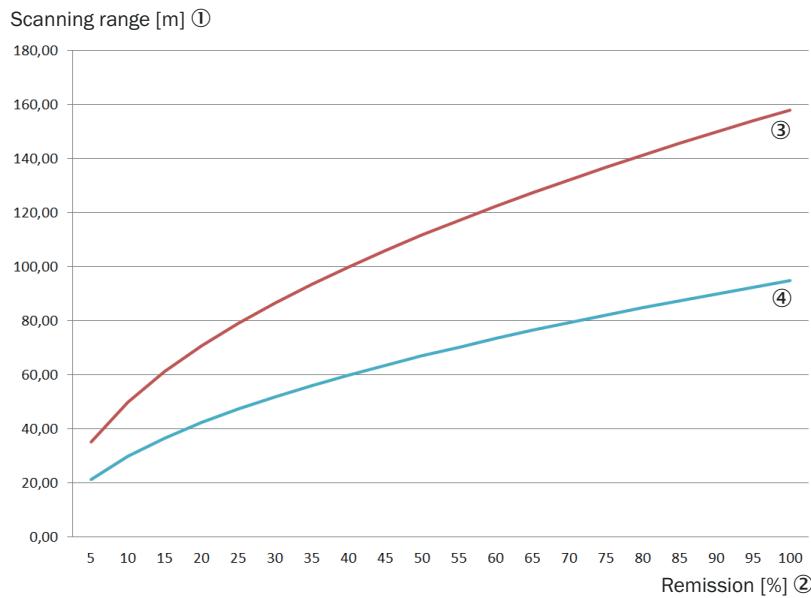


Figure 9: Scanning range as a function of object remission for various ambient light influences (no filter activated; no influence from fog, rain or dust)

- ① Scanning range in m
- ② Remission in %
- ③ Values for LD-MRS400001, LD-MRS400001S01, LD-MRS420201, LD-MRS800001
- ④ Values for LD-MRS400102, LD-MRS400102S01, LD-MRS820301

3.3.5 Object sizes

As the distance from the device increases, the laser beam expands. As a result, the diameter of the light spot on the surface of the object increases.

Values required to calculate the light spot size:

- Light spot size on the device cover: 7 mm (rounded up)
- Divergence of 1 light spot: 0.59 deg (10.4 mrad)

Formula for calculating the light spot width:

(Light spot divergence [mrad] + HDDM+ supplement [mrad]) x distance [mm] + light spot size on the device cover [mm] = light spot width [mm]

Example calculation of the light spot width at a distance of 16 m (16000 mm):

Formula for calculating the height of the light spot:

Light spot divergence [mrad] x Distance [mm] + Light spot height at the n device cover [mm] = Light spot width [mm]

Example calculation of the light spot height at a distance of 16 m (1,600 mm):

$$10.4 \text{ mrad} * 16,000 \text{ mm} + 7 \text{ mm} = 173.4 \text{ mm}$$

Formula for calculating the minimum object size:

(Light spot divergence [mrad] + angular resolution [mrad]) x distance [mm] + light spot height on the device cover [mm] = minimum object size [mm]

Example calculation of the minimum object size at a distance of 16 m (16,000 mm):



NOTE

For reliable measurement, in particular when using the device to output measured values, the laser needs to hit the object several times. Therefore, the object either needs to be larger than the minimum object size, or both the LiDAR sensor and the object must not be moving.

3.3.6 Working range and angle dependence of the scanning range

Working range

The device is designed with a central working range of 85° for four scan planes. The working range can be extended between +35° and +50° or -50° and -60° to a total of 110°. In the lateral working range, only two scan planes are available instead of four.

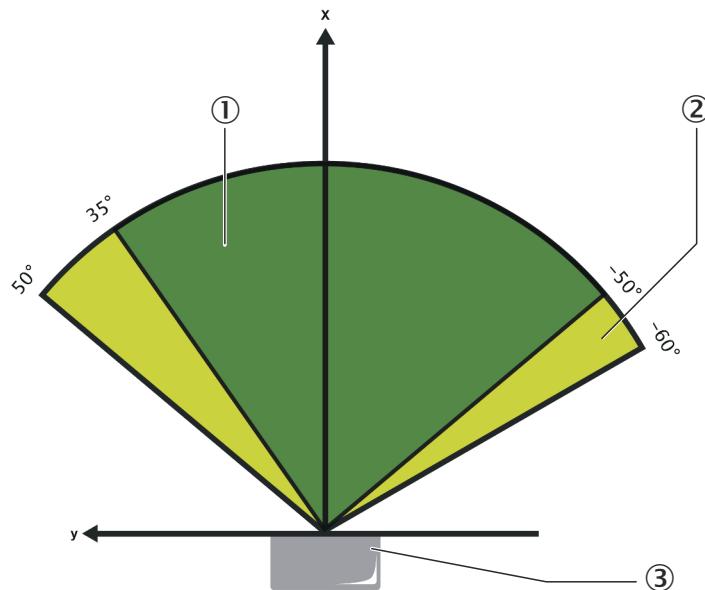


Figure 10: Working range

- (1) Central working range (green)
- (2) Lateral working range (light green)
- (3) Device

Angle dependence of the scanning range

Due to the optical design of the device, the scanning range of the working range depends on the angle.

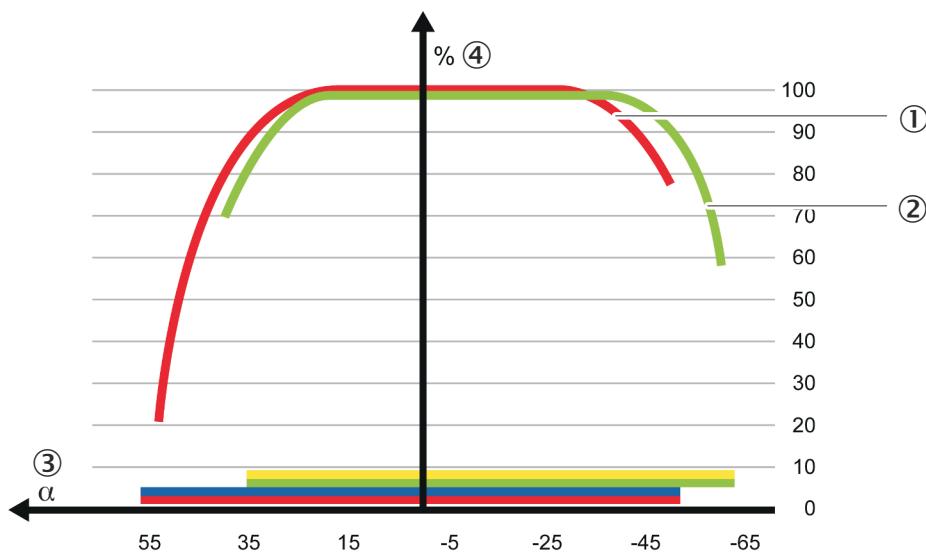


Figure 11: Angle dependence of the scanning range ¹⁾.

- ① Curve progression of the upper levels (scan planes 1 and 2)
- ② Curve progression of the lower levels (scan planes 3 and 4)
- ③ Angle in °
- ④ Scanning range in %

3.3.7 Multi-layer technology

The multi-layer technology of the device uses four scan layers at different vertical angles to compensate for pitch angle, for example when the device is attached to a vehicle. This enables the device to reliably detect an object even, for example, when the vehicle accelerates or brakes.

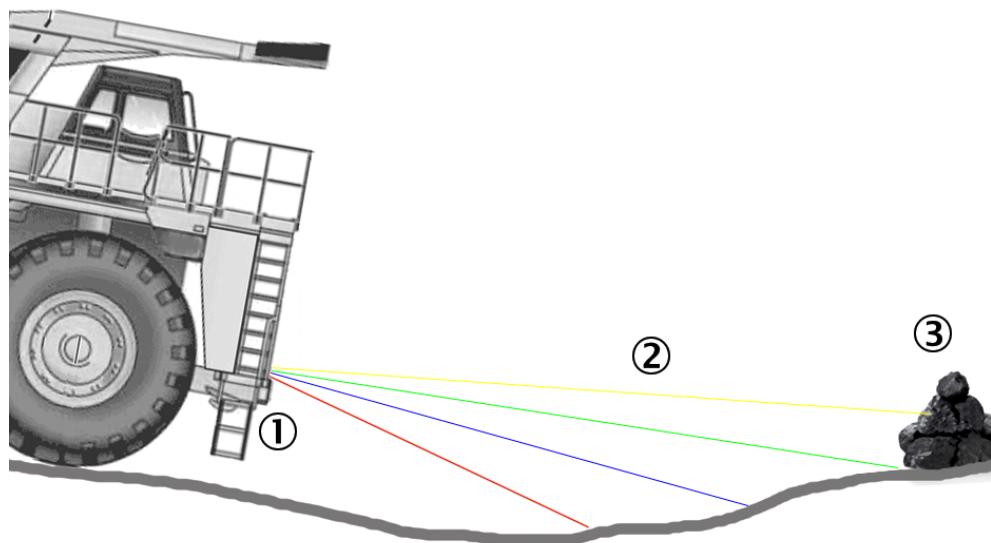


Figure 12: Multi-layer technology

- ① LiDAR sensor
- ② Scan layers
- ③ Object

¹⁾ The angle dependence of the scanning range differs slightly in the LD-MRS HD from that of the LD-MRS

The photodiode receiver of the device consists of a linear array of four independent receivers. The multilayer technology is achieved through these four receivers. Each scan planes is assigned a receiver so that the vertical aperture angle is divided into four scan planes.

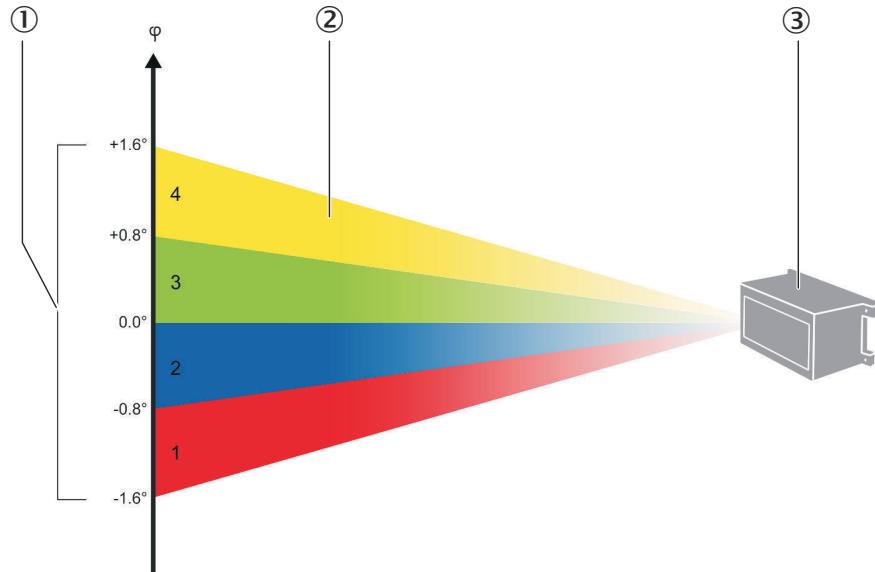


Figure 13: Scan plane principle

- ① Vertical aperture angle
- ② One of the four scan planes
- ③ Device

These four scan planes are scanned in an interlaced pattern. This means that the combinations of two scan planes (e.g. first the yellow and the green together, then the blue and the red together) are scanned one after the other, see "Angular resolution and scanning frequency", page 18.

Table 3: Naming convention

Plane	Echo 1	Echo 2	Echo 3 (not LD-MRS820301)
Yellow	Scan plane 4	Scan plane 4	Scan plane 4
Green	Scan plane 3	Scan plane 3	Scan plane 3
Blue	Scan plane 2	Scan plane 2	Scan plane 2
Red	Scan plane 1	Scan plane 1	Scan plane 1

Color tones visualize the scan planes and color saturations the echoes. The table 3 represents the defined naming convention for the respective scan layer and its default color, which are used for visualization. The saturation of the color in the visualization decreases from echo to echo.

3.3.8 Angular resolution and scanning frequency

The device can be operated at three different scanning frequencies (12.5 Hz, 25 Hz and 50 Hz), for which different angular resolution settings are possible. These parameters can be configured by the user.

Angular resolution

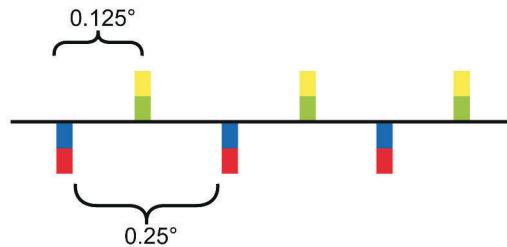


Figure 14: Angular resolution

Two scan planes are measured and evaluated simultaneously. If, for example, an angular resolution of 0.125° is specified for a particular area, this means that there is an angular increment of 0.125° between the two scan planes (e.g. red-blue) and their partners (e.g. yellow-green). The angle to the next measurement on the same scan planes is double, i.e. 0.25° in this example.

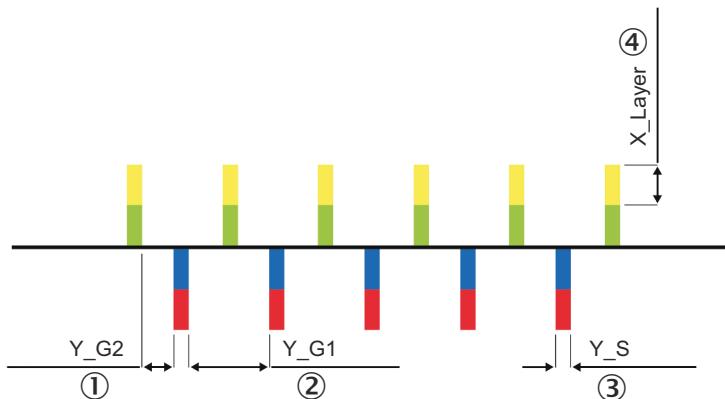


Figure 15: Example angular resolution 0.25° with distance $d = 25\text{ m}$

- ① Measuring point distance between two laser pulses (here: $Y_{G2} = 0.0742\text{ m}$)
- ② Measuring point distance in a scan planes (here: $Y_{G1} = 0.1833\text{ m}$)
- ③ Measuring point width (here: $Y_S = 0.0349\text{ m}$)
- ④ Single measuring point height (here: $X_{Layer} = 0.3491\text{ m}$)

The following tables show some values with one example:

Table 4: Angular resolution 0.125°

Distance d [m]	Y_S [m]	Y_{G1} [m]	Y_{G2} [m]	X_{Layer} [m]
10	0.0140	0.0297	0.0079	0.1396
25	0.0349	0.0742	0.0196	0.3491
50	0.0698	0.1484	0.0393	0.6981
100	0.1396	0.2967	0.0785	1.3963

Table 5: Angular resolution 0.25°

Distance d [m]	Y_S [m]	Y_{G1} [m]	Y_{G2} [m]	X_{Layer} [m]
10	0.0140	0.0733	0.0297	0.1396
25	0.0349	0.1833	0.0742	0.3491
50	0.0698	0.3665	0.1484	0.6981
100	0.1396	0.7330	0.2967	1.3963

Table 6: Angular resolution 0.5°

Distance d [m]	Y_S [m]	Y_G1 [m]	Y_G2 [m]	X_Layer [m]
10	0.0140	0.1606	0.0733	0.1396
25	0.0349	0.4014	0.01833	0.3491
50	0.0698	0.8029	0.3665	0.6981
100	0.1396	1.6057	0.7330	1.3963

In measuring mode, it is possible to select between a constant angular resolution and one that differs per sector for a scanning frequency of 12.5 Hz (adjustable with **SICK LaserView Customer Edition**²⁾. For scanning frequencies 25 Hz and 50 Hz, only the constant angular resolution is available in each case.

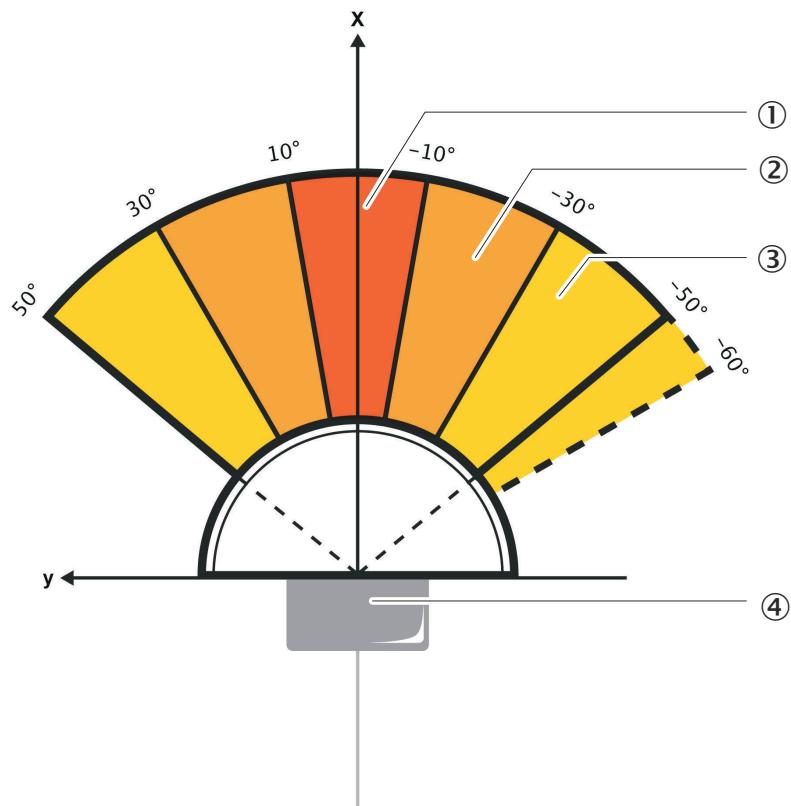


Figure 16: Angular resolution differing per sector (not LD-MRS820301)

- ① Central range angular resolution 0.125°
- ② Medium range angular resolution 0.25°
- ③ Lateral range angular resolution 0.5°
- ④ Device

The focus of the angular resolution is in a range of $\pm 10^\circ$ (central range) around the x-axis of the sensor. A slightly lower angular resolution is used in the medium range of $\pm (30^\circ \text{ to } 10^\circ)$ around the x-axis. The lateral range between $+50^\circ$ to $+30^\circ$ and -30° to -60° has a low angular resolution due to the smaller relevance of the objects located there.

²⁾)This function is not possible for field applications and for devices of type LD-MRS820301

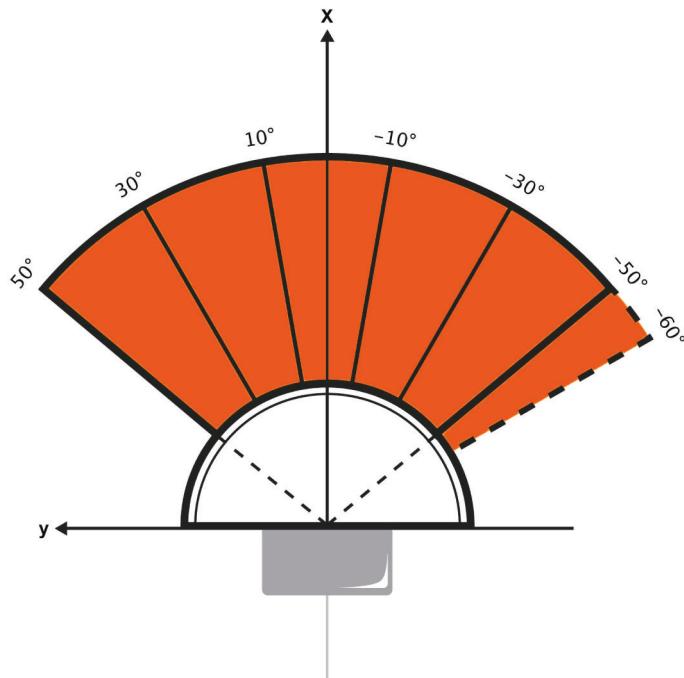
Scanning frequency 12.5 Hz

Figure 17: Scanning frequency 12.5 Hz with constant angular resolution of 0.125° (LD-MRS400xxxS01 only) or 0.25°

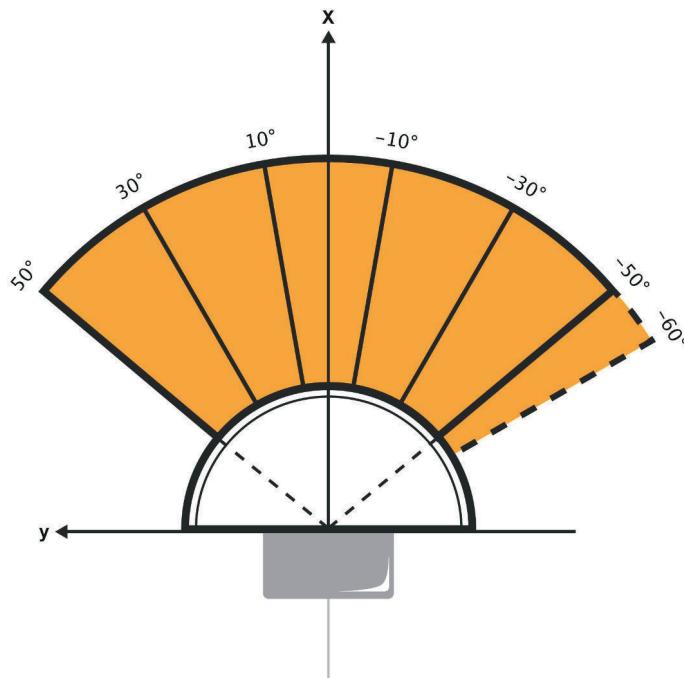
Scanning frequency 25 Hz

Figure 18: Scanning frequency 25 Hz with constant angular resolution of 0.25°

Scanning frequency 50 Hz

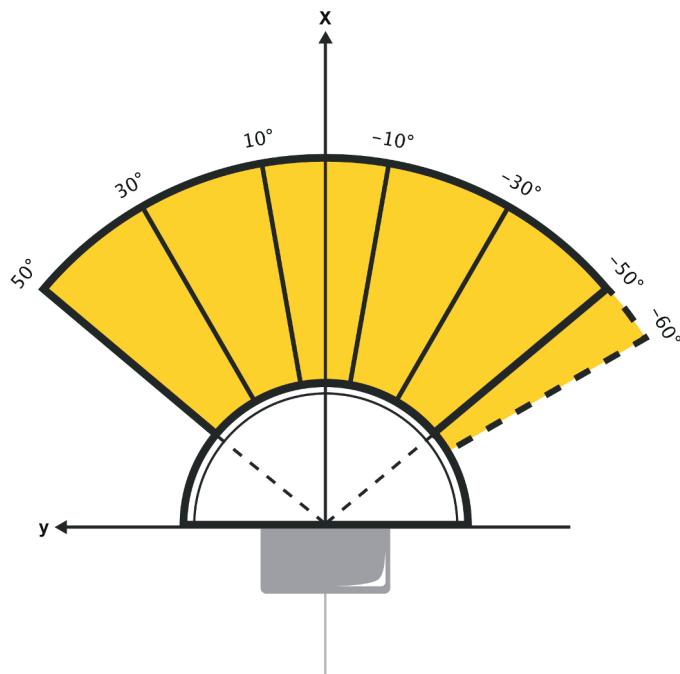
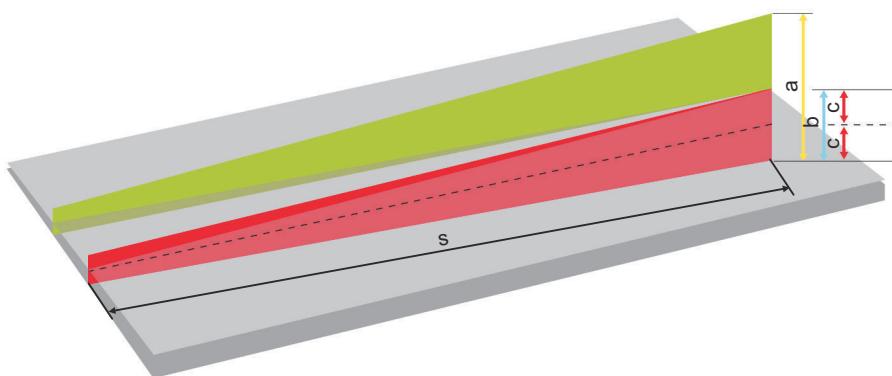


Figure 19: Scanning frequency 50 Hz with constant angular resolution of 0.5°

3.3.9 Distance between the device and the object/surface to be measured

The laser beam expands with increasing distance from the device.

With recessed installation of the device, it is important to consider how the laser beam expands as the distance increases in order to avoid incorrect measurements. If the device is mounted in an unfavorable position, depending on the distance, this could therefore mean that objects in the scanning area are detected constantly as they are hit by the laser beam.



- a Vertical beam expansion for four scan planes
- b Vertical beam expansion for two scan planes (one laser pulse)
- c Vertical beam expansion for one scan plane
- s Distance in mm

The sensor coordinate origin serves as the reference plane for the distance to be maintained to the floor/wall [see "Dimensional drawing", page 61](#).

The range-dependent beam expansion can be calculated using the following formula:

- Vertical beam expansion for a scan plane = distance × 0.014
- Horizontal beam expansion for a scan plane = distance × 0.0014

Tables [table 4](#), [table 5](#) and [table 6](#) show some example values.

3.3.10 Multi-echo analysis

The distance between the device and an object is calculated via the time-of-flight of the emitted pulse. The device can evaluate up to three³⁾ echo signals for each measuring beam to deliver reliable measurement results, even under adverse ambient conditions.

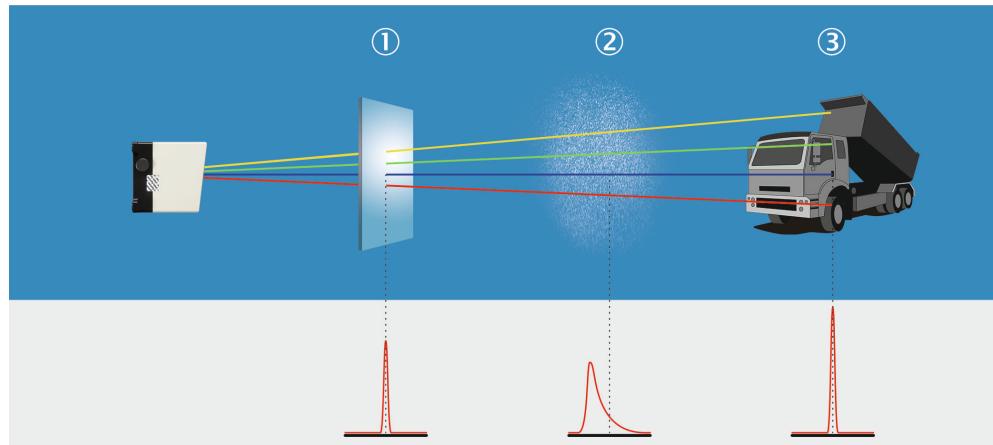


Figure 20: Multi-echo analysis: example industrial application for mining

- ① Glass
- ② Dust
- ③ Measuring object

3.3.11 Field application

Depending on the type, the device uses the integrated field application to analyze up to 16 detection fields within its scan range.

Object detections (events) are signaled by the device via max. 10 outputs. The outputs can be assigned to the external, physical ports (each configurable as input or output) of max. two CAN modules (optional accessories) via the CAN bus. A CAN module offers 8 I/O ports each.

You can use the field application to implement systems for collision protection, object protection or access monitoring, for example.

³⁾ LD-MRS820301: two echo signals

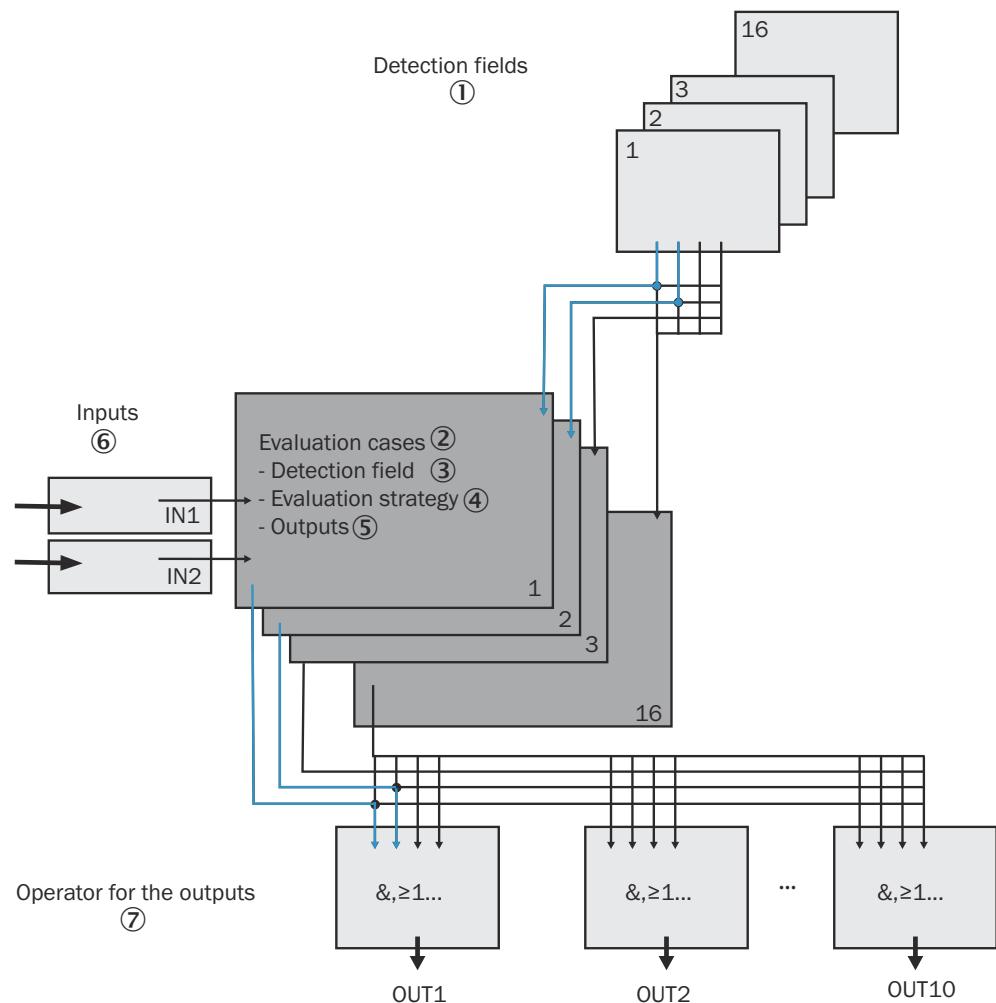


Figure 21: Principle of field application

- ① Detection fields
- ② Evaluation cases
- ③ Detection field
- ④ Analysis strategy
- ⑤ Outputs
- ⑥ Inputs
- ⑦ Linking of outputs

The device is adapted to the evaluation situation with the help of up to 16 evaluation cases. In the evaluation case, one of 16 configurable detection fields, an evaluation strategy, an output, and possibly a combination of inputs or time periods that activate the evaluation case are selected. For each output, a link is chosen which determines the result of the output if more than one evaluation case affects the output.

In the example in figure 21, detection field 1 is used in evaluation case 1, and detection field 2 is used in evaluation case 2. Both evaluation cases act on output OUT1. If the results of the evaluation cases are AND-linked, the output only switches when both evaluation cases report an event.

3.3.11.1 Evaluation cases

An evaluation case determines which detection field is evaluated in which way and on which output it acts.

You can configure up to 16 evaluation cases; all configured evaluation cases are active simultaneously.

For each evaluation case, configure in SOPAS ET:

- Inputs or time periods that activate an evaluation case, if applicable. If nothing is specified, the evaluation case is always active.
- The evaluation strategy
- The detection field
- The output affected by the analysis case
- The response time of the output

Inputs

If the evaluation case is not permanently active, you can configure an input combination that activates the evaluation case.

Table 7: Examples of input combinations

Input 1	Input 2	Evaluation case
Active high	Active low	1
Active high	Active high	2
Active low	Active high	3
Active low	Active low	4

NOTE

An input combination can also be defined for several evaluation cases, then e.g. two evaluation cases become active simultaneously.

Analysis strategy

In SOPAS ET, you choose from the following possible evaluation strategies:

- **Pixel analysis:** The device evaluates the entire area of the field. Each individual beam is taken into account in evaluation. If an object enters the field, this result is forwarded to the corresponding output.
- **Blanking:** The device evaluates the entire area of the field. However, objects that are smaller than the specified size are ignored. An object is only detected if it is larger than the configured blanking size. However, this only applies to objects that are at the maximum distance at which they still meet the criteria for the minimum object size. At greater distances, the set blanking size can no longer be achieved by the optical resolution of the device. The device behaves exactly as with pixel evaluation.
- **Contour:** The device also evaluates the existence of a contour, which has to be fully situated within the evaluation field at all times. This allows the device to detect, for example, that a door opens outwards or that the position of the device has changed. It is also possible to detect someone crawling beneath a vertical evaluation field or a laser beam deflected in a mirror. Blanking can be used to hide the missing part of the contour up to a certain size.

Response time

Define a response time for the **Pixel analysis**, **Blanking** and **Contour** evaluation strategies. For a device to detect an object using the **Pixel analysis** and **Blanking** evaluation strategies, it must be detected at one point for at least the duration of the response time. For the **Contour** evaluation strategy, the contour breach must be detected at the same location for at least the duration of the response time.

Manipulation prevention

When Pixel analysis is configured, dazzling can cause the device to stop monitoring a field. When Blanking is configured, small objects in the vicinity of the device can cause large shadows.

If you use detection fields at a distance to the device, the object or the object erroneously measured due to dazzle lies outside the detection field and is not detected.

To prevent this, you can configure the **Manipulation protection** option.

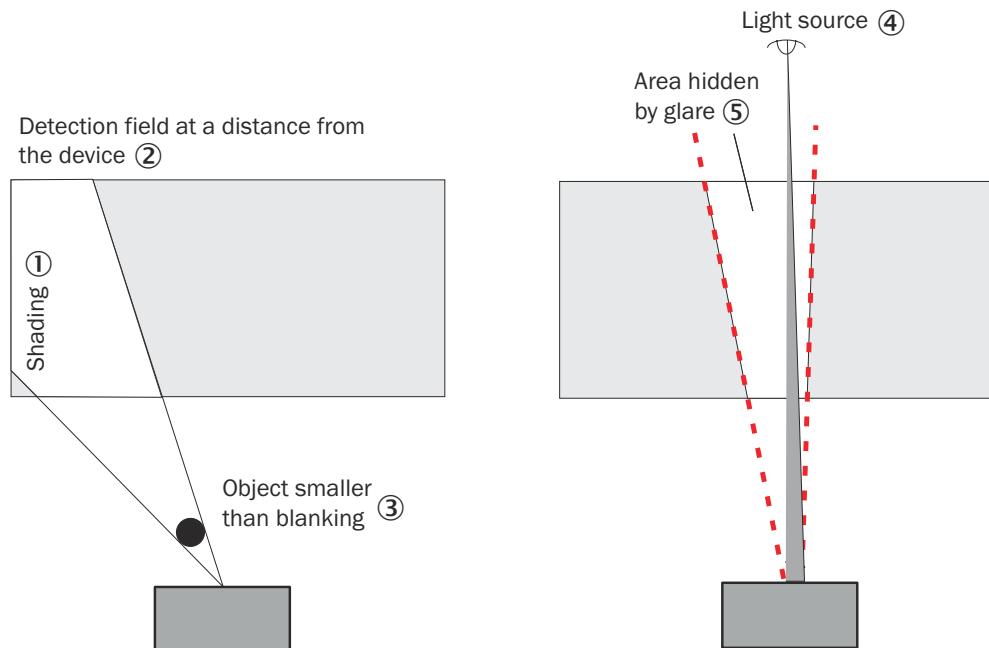


Figure 22: Tamper-proofing against shadowing and dazzle

- ① Shading
- ② Detection field with distance to the device
- ③ Object smaller than blanking
- ④ Light source
- ⑤ Blanked area

The **Manipulation protection** option switches the detection field:

- If an object less than or equal to the blanked object size is in front of the laser output aperture of the device for the response time configured for manipulation protection.
- If the device is blanked for longer than the response time configured for manipulation protection.

Detection field

For the evaluation case, select a field from the already configured detection fields. Its shape must fit the evaluation strategy [see "Detection fields", page 27](#).

Output

Select one of the outputs for the evaluation case. If several evaluation cases act on one output, you must determine how the results of the evaluation cases are linked [see "Linking evaluation cases at the output", page 27](#).



NOTE

The respective output must be configured for "Application".

Negating the result

Negating the result reverses the field evaluation output. The output used is thus switched, for example, if the detection field is free or if the contour is not interrupted.

NOTE

Do not confuse negation of the result with the Active HIGH/Active LOW setting of the outputs see "[Linking of evaluation cases at the output](#)", page 27.

3.3.11.2 Detection fields

Using the integrated field application, you can configure up to 16 detection fields. The size and shape of these detection fields are (almost) freely configurable.

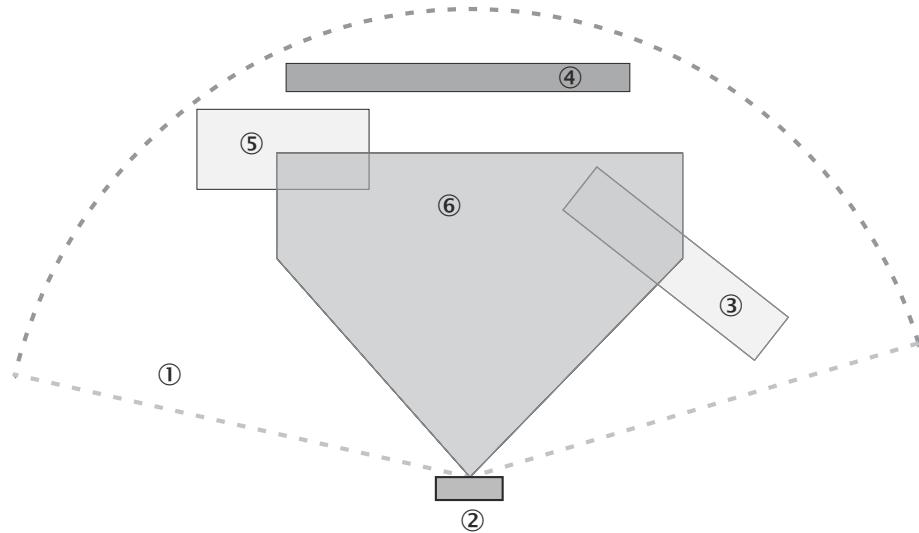


Figure 23: Detection field shape examples

- ① Working range
- ② Device
- ③ Rotated detection field
- ④ Detection field for contour monitoring
- ⑤ Square detection field with distance to the device
- ⑥ Polygonal detection field

The detection fields can be drawn using SOPAS ET according to the needs of your application. Detection fields can have the following properties:

- Polygon
- Square
- Beginning on device
- With distance to device ("island field")

If the area to be monitored changes, the field can be easily reconfigured using the SOPAS ET configuration software.

3.3.11.3 Linking of evaluation cases at the output

If several evaluation cases act on one output, you must determine how the results of the evaluation cases are linked. The respective results can be linked with AND or OR.

The outputs are configured as **Active Low** by default. You can also configure them as **Active High**.

Resetting an output

In the default setting, the outputs are immediately reset to the deactivated state. You can configure a delay of up to 10 s (e.g. to activate a horn or to transmit the output signal to a PLC).

Alternatively, you can also reset the output via an input. The output is only reset when the assigned input assumes the configured status.

3.3.12 Data interface

Ethernet interface

The Ethernet interface has a data transmission rate of 100 Mbit/s. The interface is a TCP/IP interface supporting full duplex.

The Ethernet interface allows the configuration of the device as well as the output of measured values for measuring operation.

The factory setting for the Ethernet interface is as follows:

- IP address: 192.168.0.1
- Subnet mask: 255.255.255.0
- TCP port: 2111

Depending on the configuration of the device, different data types are available via the Ethernet interface:

- Scan data: Data type 0x2202 (only in measuring operation)
- Warning and error messages: Data type 0x2030
- Commands and responses: Data types 0x2010 and 0x2020

NOTE

For additional information, refer to the **Ethernet Data Protocol telegram listing**, no. 8014492 on the product page.

which can be accessed via the **SICK Product ID pid.sick.com/{P/N}**

{P/N} corresponds to the part number of the product (see type label).

For a description of the electrical interfaces see "Connection diagram", page 40.

3.3.13 Communicating data via telegrams

In measuring operation, the device communicates with a connected host by means of telegrams via the Ethernet interface.

The following functions can be carried out with telegrams:

- Request measured values via the host and then output them once via the device
- Parameter setting by the host for the configuration of the device
- Parameters and status log querying by the host.

NOTE

A detailed list of the different telegrams can be found in the **Ethernet Data Protocol telegram listing**, no. 8014492 on the product page.

which can be accessed via the **SICK Product ID pid.sick.com/{P/N}**

{P/N} corresponds to the part number of the product (see type label).

Frame and coding of the telegrams

The payload varies depending on the coding.

Table 8: Frame of the telegrams when using ASCII coding (CoLa-A)

	Frame	Telegram	Frame
Designation	STX	Payload	ETX
Length (Byte)	1		1
Description	Start of text character	ASCII coded	End of text character

3.3.14 Object tracking (LD-MRSxxxxS01 / LD-MRS420201 only)

By means of object tracking, the device outputs preprocessed data that can then be used for advanced applications. No additional hardware or software is required for object tracking.

The device outputs the following dynamic object parameters in relation to the proper motion data:

- Position of the object
- Speed of the object
- Size (length and width) of the object
- Direction of movement of the object
- Age (scans, time) of the object

Applications include:

- Navigation
- Collision protection
- Monitoring

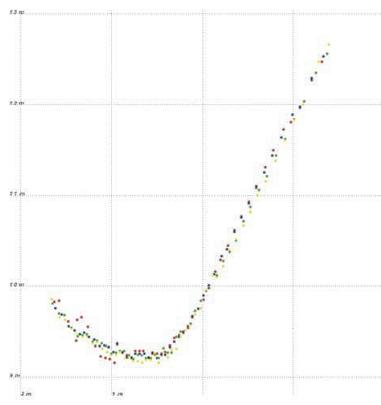
With object tracking, up to 64 objects can be tracked simultaneously. The object information is processed in real time. The real-time data is output via an Ethernet interface or with a reduced number (max. 64) of transmittable objects via CAN bus.

3.3.14.1 Raw data processing

The raw data is processed in four stages during object tracking.

- Raw data
- Object contour
- Bounding Box
- Object Box

Raw data



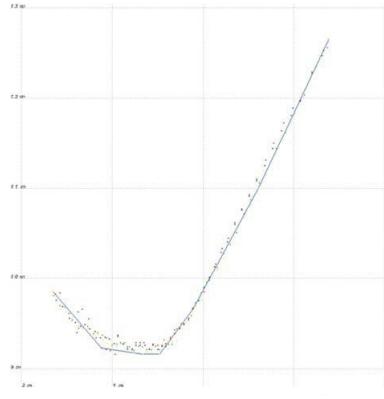
First, the device analyzes the scan data. This analysis is referred to as preprocessing. During this process, it classifies every measured point and divides them up into values based on contamination, atmospheric disturbances (e.g. rain), and impact on the object.

The device outputs scan data as data types exclusively via the Ethernet interface. It should be noted that scan data output from the device is polar in the sensor coordinate system.

NOTE

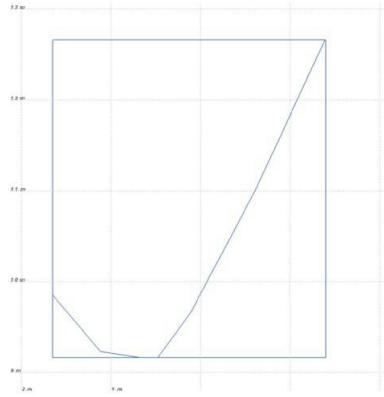
Scan data is transmitted from the device in the sensor coordinate system.

Object contour



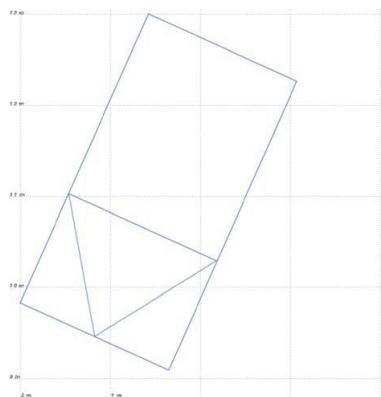
When you activate the **Show Contour** option, the device generates an object contour from the raw data. The scan data is divided to form groups consisting of related scan points. Segmentation depends on the proper motion of the vehicle.

Boundary area



When activating the **Show Bounding Box** option, the device generates a rectangular bounding box around the object contour from the raw data. The proper motion of the vehicle and the history of the scan data will affect the object contour.

Object



If you activate the **Show Object Boxes** and **Show direction** options, the device generates a rectangular box around the object from the raw data and outputs the following data about it:

- Position of the object
- Speed of the object
- Size (length and width) of the object
- Direction of movement of the object
- Age (scans, time) of the object (optional)
- Contour of the object

Ego motion data

It is possible to transmit information on the proper motion data of the vehicle to the device. The scanner mounted on the vehicle forwards the data to the device via Ethernet or CAN bus. This data is taken into account in object tracking and in the calculation of speed and direction characteristics of the detected objects. Without this information, the scanner assumes that its vehicle is not moving.

3.3.14.2 Object tracking settings

Near range filter Suppressor

The near range filter **Suppressor** can be activated during object tracking to improve measurement results under difficult conditions. Together with the reduction of the lower 4 scan planes, the device is both less sensitive to dust/atmospheric disturbances and has the full scanning range over the upper 4 scan layers. Only possible for the LD-MRS 8-Layer.

Sensitivity reduction (not LD-MRS820301)

If the **Lower 4 layer reduced range** setting is selected via the **LayerRangeReduction** setting, the measurements in the near range up to 15 m are not used in object tracking when the **Suppressor** is active.

Depending on the application, reducing the sensitivity can prevent and clean up erroneous measurements. For use on a vehicle in a dusty environment, it is possible to reduce the sensitivity of the lower scan planes yet retain the full scanning range of the upper scan layers to make it possible to detect obstacles or objects that are further away.

Table 9: Setting the sensitivity of the scan planes

Value	Upper scan planes	Lower scan planes	Application
0 (default)	Full sensitivity	Full sensitivity	Normal
1	Full sensitivity	Reduced sensitivity	Vehicles in dusty environment

Value	Upper scan planes	Lower scan planes	Application
2	Reduced sensitivity	Full sensitivity	Horizontal measurements, possible interference from sun low on the horizon
3	Reduced sensitivity	Reduced sensitivity	Profile measurements with sun in background



NOTE

Note that the specifications for the upper scan plane and the lower scan layer are reversed if the device has been mounted overhead and the **Upside down active** option has been activated. If the **Upside down active** option is activated, the sequence is adjusted accordingly.

The sensitivity reduction corresponds to typ. 60% of the previous scanning range.

Clutter remover (not LD-MRS820301)

For every echo that reflects off an object, the signal amplitude is assessed twice – with a lower and higher threshold. If both thresholds are exceeded, it can be assumed that the measurement target is solid and fixed. If only the lower threshold is exceeded, the target is scattered, for example, by dust. Within the output of measured values, the measured values are marked as **Clutter** and are not included in the object calculation.



NOTE

Only use this option in cases when it is known that there is a chance of disruptive measurements occurring in the measuring situation. Otherwise, measured values will be lost.

Sensitivity filter (Noise control)

The filter can only be applied to the full scan plane range(**LayerRange Reduction > Full Range**).

In extreme cases of ambient light (e.g. sunlight), erroneous measurements may be taken, which can be evaluated and filtered by performing a plausibility check on a downstream external computer.

The **Noise control active** function activates an automatic sensitivity setting that monitors erroneous measurements at > 100 m and uses them to update the sensitivity of the receivers.

The automatic sensitivity adjustment means that the scanning range will be between the maximum and the threshold for reduced sensitivity.

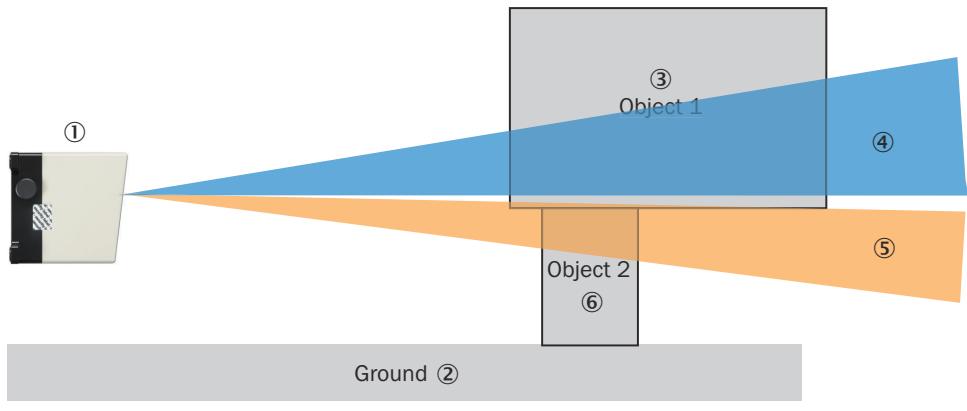
Threshold (Threshold8ITrackingMerge)

The threshold is adjustable (0 ... 100%).

Coverage value (Strategy8ITrackingMerge)

For the LD-MRS with 8 scan plane, the behavior of object tracking can be influenced if the upper and the lower 4 scan planes detect objects of different sizes.

Side view ⑦



Top view ⑧



Figure 24: Coverage value

- ① Device
- ② Base
- ③ Object 1
- ④ Upper 4 scan planes
- ⑤ Lower 4 scan planes
- ⑥ Object 2
- ⑦ Side view
- ⑧ Top view

The formula for calculating coverage value α is adjustable

- **Harmonic** (default setting) $\alpha = 2 \times o_1 \times o_2 / (o_1 + o_2)$: Merge objects only when they have a very similar size to avoid tracking errors/distortions (e.g. speed progression). In small objects, this will result in a small resulting overlap value if the other object is larger.
- **Max overlapping** $\alpha = \max(o_1, o_2)$: Avoid small objects. Possible side effect: Tracking errors/distortions possible due to permanent change of object size.
- **Mean** $\alpha = (o_1 + o_2) / 2$: Objects of the lower scan planes with an α -value above the threshold are ignored (and not, as with **Harmonic**, merged with objects of the upper scan layer): Small, covered objects provide little additional information and can therefore be ignored. Collision avoidance is given by the object of the upper scan plane.

Occupancy calculation for [see figure 24, page 33](#):

- Upper scan planes: Overlap o_1 (object 1 by object 2): 30%
- Lower scan planes: Overlap o_2 (object 2 by object 1): 100%
- Coverage value $\alpha = 2 \times o_1 \times o_2 / (o_1 + o_2) = 6000 / 130 = 46$
- If $\alpha \geq$ threshold (default: 75): 1 object, otherwise: 2 objects (i.e.: due to relatively high threshold "preference" to 2 separate objects)

4 Transport and storage

4.1 Transport



NOTICE

Damage due to improper transport!

- The product must be packaged with protection against shock and damp.
- Recommendation: Use the original packaging.
- Note the symbols on the packaging.
- Do not remove packaging until immediately before you start mounting.

4.2 Unpacking

- To protect the device against condensation, allow it to equilibrate with the ambient temperature before unpacking if necessary.
- Handle the device with care and protect it from mechanical damage.

4.3 Transport inspection

Immediately upon receipt in Goods-in, check the delivery for completeness and for any damage that may have occurred in transit. In the case of transit damage that is visible externally, proceed as follows:

- Do not accept the delivery or only do so conditionally.
- Note the scope of damage on the transport documents or on the transport company's delivery note.
- File a complaint.



NOTE

Complaints regarding defects should be filed as soon as these are detected. Damage claims are only valid before the applicable complaint deadlines.

4.4 Storage

- Do not store outdoors.
- Store in a place protected from moisture and dust.
- Recommendation: Use the original packaging.
- To allow any residual dampness to evaporate, do not package in airtight containers.
- Do not expose to any aggressive substances.
- Protect from sunlight.
- Avoid mechanical shocks.
- Storage temperature: see "Technical data", page 57.
- Relative humidity: see "Technical data", page 57.
- For storage periods of longer than 3 months, check the general condition of all components and packaging on a regular basis.

5 Mounting

5.1 Mounting instructions

- Observe the technical data.
- Protect the sensor from direct sunlight.
- To prevent condensation, avoid exposing the device to rapid changes in temperature.
- The mounting site has to be designed for the weight of the device.
- Protect the device from moisture, contamination, and damage.
- Make sure that the status indicator is clearly visible.

5.2 Mounting the device

1. Using the fixing holes, mount the device (see "Dimensional drawing", page 61) to a prepared bracket using 4 M6 screws with washers and lock washers. Mounting brackets are available as accessories, "Accessories", page 64.
2. Make the electrical connection. Attach and tighten the tension-free cable, see "Overview of the installation steps", page 39.
3. Align the vertical center line of the field of view of the device with the center of the area to be monitored.
4. Switch on the supply voltage.
5. Perform a fine adjustment using a test target and, if necessary, use the alignment aid.

5.3 Mounting multiple devices



NOTICE RISK OF INTERFERENCE FROM OTHER DEVICES!

Radiation sources with a wavelength of 905 nm can cause interference if they affect the device directly.

The device has been designed to minimize the probability of mutual interference, including between different LiDAR sensors. To rule out even the slightest effects on the measurement accuracy, the devices should be arranged such the laser beams are not received by another device.

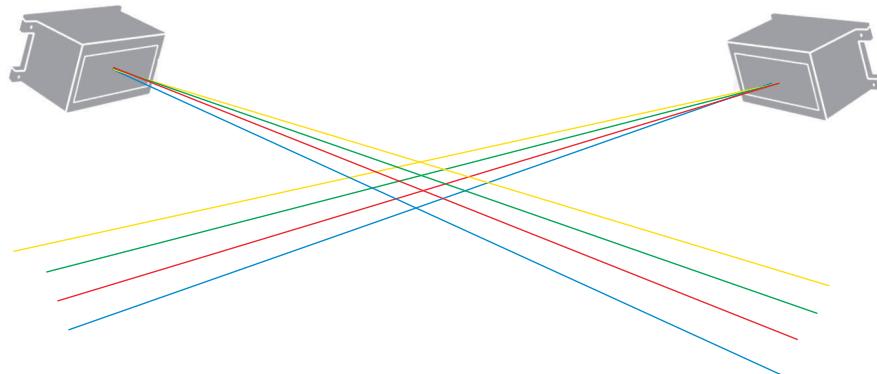


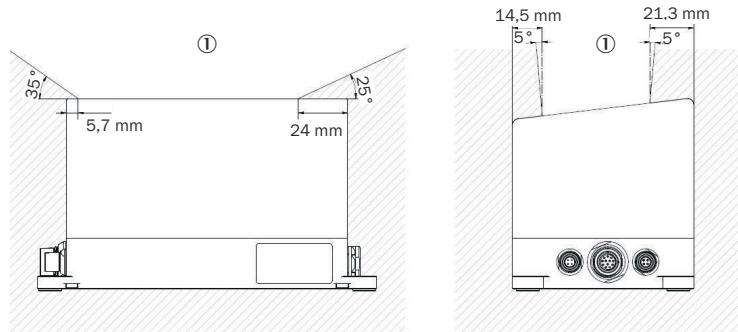
Figure 25: Arrangement for 2 devices

5.4 Overhead mounting (LD-MRS8xxxxx only)

If two LD-MRS 8-Layers are used, the scanning range can be extended by mounting the left LD-MRS 8-Layers overhead in the direction of travel.

If a device is mounted overhead, the **Upside down active** option must be activated in SOPAS ET. The installation position is selected from the Laserview/Telegram listing to ensure that the scan data output, coordinates and object data can be output correctly.

5.5 Boundary conditions for integration



① Area to be kept clear

The following measures facilitate integration of the device into a vehicle:

- When integrating the device, keep at least the marked areas free.
- Only select materials with a low remission for the materials adjacent to the field of view.
- Avoid edges in the area of the viewing window. For optimal design integration, the transition between the surrounding material and the device should be flat.

In cooperation with SICK AG, a customer-specific solution can also be developed for the housing cover so that it adapts to the conditions of the vehicle and the vehicle contour blends into the contour of the device without corners and edges.

6 Electrical installation

6.1 Wiring instructions



NOTE

Pre-assembled cables can be found on the product page.

The page can be accessed via the **SICK Product ID: pid.sick.com/{P/N}/{S/N}**

{P/N} corresponds to the part number of the product, see type label.

{S/N} corresponds to the serial number of the product, see type label (if indicated).



NOTICE

Faults during operation and defects in the device or the system

Incorrect wiring may result in operational faults and defects.

- Follow the wiring notes precisely.

For data transmission, use only shielded cables with twisted-pair wires.

Connect the connecting cables in a de-energized state. Do not switch on the supply voltage until installation is complete and all connecting cables are connected to the device and control.

Wire cross-sections in the supply cable from the customer's power system must be implemented in accordance with the applicable standards.

6.2 Prerequisites for safe operation of the device



WARNING

Risk of injury and damage caused by electrical current!

As a result of equipotential bonding currents between the device and other grounded devices in the system, faulty grounding of the device can give rise to the following dangers and faults:

- Dangerous voltages are applied to the metal housings.
- Devices will behave incorrectly or be destroyed.
- Cable shielding will be damaged by overheating and cause cable fires.

Remedial measures

- Only skilled electricians should be permitted to carry out work on the electrical system.
- If the cable insulation is damaged, disconnect the voltage supply immediately and have the damage repaired.
- Ensure that the ground potential is the same at all grounding points.
- Where local conditions do not meet the requirements for a safe earthing method, take appropriate measures. For example, ensure low-impedance and current-carrying equipotential bonding.

The device is connected to the peripheral devices (any local trigger sensor(s), system controller) via shielded cables. The cable shield – for the data cable, for example – rests against the metal housing of the device.

The device can be grounded through the cable shield or through a blind tapped hole in the housing, for example.

If the peripheral devices have metal housings and the cable shields are also in contact with their housings, it is assumed that all devices involved in the installation have the **same ground potential**.

This is achieved by complying with the following conditions:

- Mounting the devices on conductive metal surfaces
- Correctly grounding the devices and metal surfaces in the system
- If necessary: low-impedance and current-carrying equipotential bonding between areas with different ground potentials

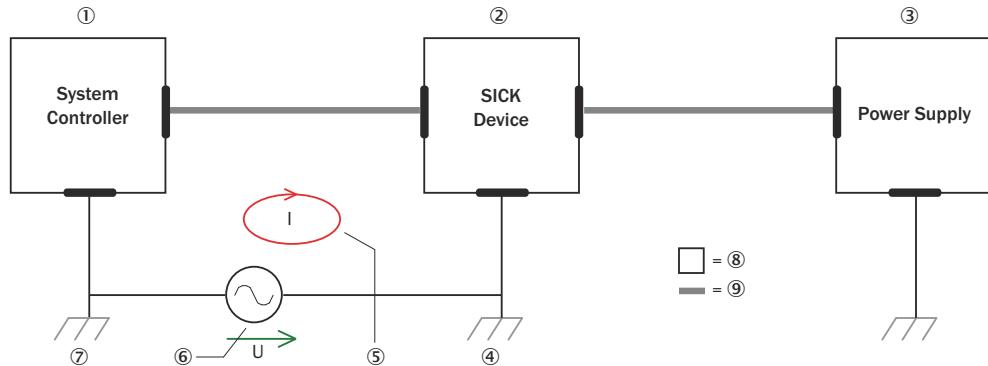


Figure 26: Example: Occurrence of equipotential bonding currents in the system configuration

- ① System controller
- ② Device
- ③ Voltage supply
- ④ Grounding point 2
- ⑤ Closed current loop with equalizing currents via cable shield
- ⑥ Ground potential difference
- ⑦ Grounding point 1
- ⑧ Metal housing
- ⑨ Shielded electrical cable

If these conditions are not fulfilled, equipotential bonding currents can flow along the cable shielding between the devices due to differing ground potentials and cause the hazards specified. This is, for example, possible in cases where there are devices within a widely distributed system covering several buildings.

Remedial measures

The most common solution to prevent equipotential bonding currents on cable shields is to ensure low-impedance and current-carrying equipotential bonding. If this equipotential bonding is not possible, the following solution approaches serve as a suggestion.



NOTICE

We expressly advise against opening up the cable shields. This would mean that the EMC limit values can no longer be complied with and that the safe operation of the device data interfaces can no longer be guaranteed.

Measures for widely distributed system installations

On widely distributed system installations with correspondingly large potential differences, the setting up of local islands and connecting them using commercially available **electro-optical signal isolators** is recommended. This measure achieves a high degree of resistance to electromagnetic interference.

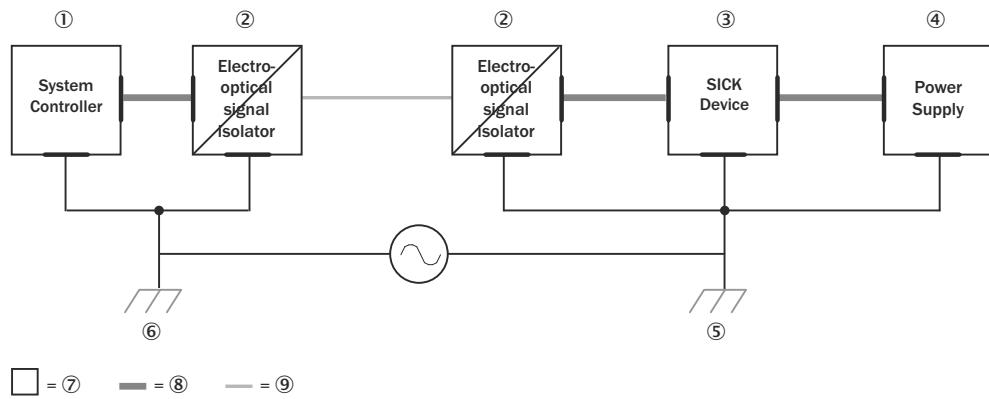


Figure 27: Example: Prevention of equipotential bonding currents in the system configuration by the use of electro-optical signal isolators

- ① System controller
- ② Electro-optical signal isolator
- ③ Device
- ④ Voltage supply
- ⑤ Grounding point 2
- ⑥ Grounding point 1
- ⑦ Metal housing
- ⑧ Shielded electrical cable
- ⑨ Optical fiber

The use of electro-optical signal isolators between the islands isolates the ground loop. Within the islands, a stable equipotential bonding prevents equalizing currents on the cable shields.

Measures for small system installations

For smaller installations with only slight potential differences, insulated mounting of the device and peripheral devices may be an adequate solution.

Even in the event of large differences in the ground potential, ground loops are effectively prevented. As a result, equalizing currents can no longer flow via the cable shields and metal housing.



NOTICE

The voltage supply for the device and the connected peripheral devices must also guarantee the required level of insulation.

Under certain circumstances, a tangible potential can develop between the insulated metal housings and the local ground potential.

6.3 Overview of the installation steps

1. Set up the voltage supply for the device.
2. Connect the computer temporarily (configuration).
3. Select depending on the application:
 - o Measuring operation: Wire the data interface for operation (application-dependent).
 - o Field application: Wire the external switching inputs and switching outputs. Connect optional CAN modules to the supply voltage.

6.4 Connection diagram



NOTE

The recommended connecting cables and their associated technical data can be found on the online product page.

The page can be accessed via the **SICK Product ID: pid.sick.com/{P/N}/{S/N}**

{P/N} corresponds to the part number of the product, see type label.

{S/N} corresponds to the serial number of the product, see type label (if indicated).

Power connection

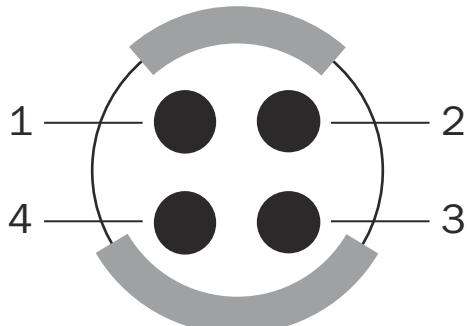


Figure 28: Male connector, 4-pin

Table 10: Pin assignment for PWR connection

Contact	Labels	Description	Core color part no. 2049823 ¹⁾
1	Power GND	Supply voltage: Ground	Black/White
2	Vs	Supply voltage	Red/Yellow
3	Vs	Supply voltage	Red/Green
4	Power GND	Supply voltage: Ground	Black/Brown

¹⁾ Data only valid when using the specified connecting cable with flying leads, which is available as an accessory

Ethernet connection

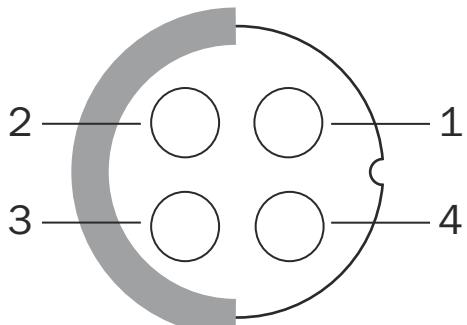


Figure 29: Female connector, 4-pin

Table 11: Pin assignment for Ethernet connection

Contact	Labels	Description
1	RX-	Receiver-
2	TX+	Sender+
3	TX-	Sender-

Contact	Labels	Description
4	RX+	Receiver+

Data interface/Synchronization connection

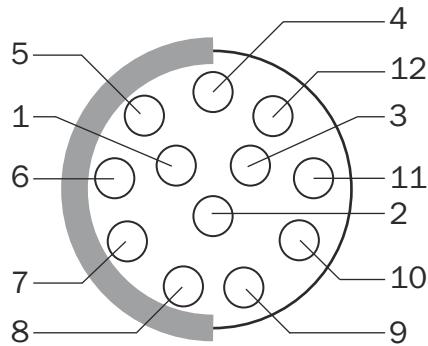


Figure 30: Female connector, 12-pin

Table 12: Data interface/Synchronization pin assignment

Contact	Labels	Description
1	TxD	RS-232, Transmit
2	Sync-out	Sensor Sync.
3	Sync-in	Sensor Sync.
4	Data GND (Sync-in)	Data Ground
5	Data GND (Sync-out)	Data Ground
6	Data GND (TxD, RS-232)	Data Ground
7	RxD	RS-232, Receive
8	Data GND (RxD, RS-232)	Data Ground
9	CAN_L1	CAN bus (connection 1)
10	CAN_H1	CAN bus (connection 1)
11	CAN_L2	CAN bus (connection 2)
12	CAN_H2	CAN bus (connection 2)

7 Commissioning

7.1 Overview of the commissioning steps

Commissioning as well as configuration of the device is done with the following tools depending on the intended use:

- **SICK LaserView Customer Edition** Visualization Tool for measuring operation. Installation and use of the **SICK LaserView Customer Edition** as well as the configuration of the device is described in the “SICK LaserView Customer Edition Visualization Tool” operating instructions (part no. 8013786, German edition).
- SOPAS ET configuration software for field application. Installation and use of SOPAS ET is described in this section as well as in the device-related online help in SOPAS ET.

Overview of the commissioning steps for the field application

1. Install the SOPAS ET configuration software.
2. Establish communication with the device.
3. Create an application-specific parameter set with SOPAS ET and save it permanently in the non-volatile device memory and on the computer.
4. Test the device for correct functioning.

7.2 SOPAS ET configuration software

The interactive configuration is performed using the SOPAS Engineering Tool (SOPAS ET) software. You can use this configuration software to parameterize and test the measuring properties, evaluation behavior, and output properties of the system as required. The configuration data are stored and archived as a parameter set (project file) on the computer.



NOTE

The most up-to-date version of the SOPAS ET software can be downloaded from www.sick.com/SOPAS_ET. The respective system requirements for installing SOPAS ET are also specified there.

Downloading and installing SOPAS ET

1. Start computer.
 2. Download and install the latest version of the SOPAS ET configuration software, as well as current device description files (*.sdd) for the device variant from the online product page for the software by following the instructions provided there.
 3. In this case, select the “Complete” option as suggested by the installation wizard. Administrator rights may be required on the computer to install the software.
 4. When the installation is finished, start the **SOPAS ET** program option. Path: Start > Programs > SICK > SOPAS ET Engineering Tool > SOPAS.
 5. Establish a connection between SOPAS ET and the device. In order to do this, select the desired communication interface for searching in the connection wizard. (Default Ethernet address: IP address: 192.168.0.1, subnet mask: 255.255.255.0).
- ✓ SOPAS ET establishes communication with the device and loads the associated device description file.

SOPAS ET default settings

Table 13: SOPAS ET default settings

Parameters	Value
Program interface language	English (you must restart the software after making any changes)
Units of length	Metric
Download the parameters to the device	Immediately after a change, temporarily in the RAM of the device
Upload the parameters from the device	Automated after online switching
Window arrangement	3 (project tree, help, working area)
Serial communication	COM1: 9,600 Bd / 19,200 Bd, 8 data bits, no parity, 1 stop bit

7.3 Establishing communication with the device



NOTE

To communicate via Ethernet TCP/IP, the TCP/IP protocol on the computer must be active.

When connecting a PC/host, please adhere to the following order:

1. Connect the computer to the device with a data cable.
2. Switch on computer.
3. Switch on supply voltage of the device.
- ✓ The device performs a self-test and initializes itself.

Connecting data interfaces

Connect the device to the computer via one of the following data interfaces:

- Ethernet

Starting SOPAS ET and calling up scan assistant

1. Start SOPAS ET.
2. In the main window under **Scan Assistant**, click on the **Configuration** button.
- ✓ The **Scan Assistant** dialog window appears.

Configuring the Ethernet connection



NOTE

Deactivate all programs on your computer to access Ethernet or TCP/IP.

1. In the **Scan Assistant** dialog box under **Internet Protocol, IP Protocol**, select the **Use Auto-IP** checkbox.
2. Confirm the settings in the **Scan Assistant** dialog window by clicking **OK**.
- ✓ The **Scan Assistant** dialog window closes.

Performing a scan

1. In the **Scan Assistant** dialog window, click the **Start Scan** button.
2. Select the listed devices and confirm by clicking **Add Device**.
- ✓ The connection is used to search for connected devices. SOPAS ET adds the devices found to the project tree and loads the current parameter set to the device via upload.

7.4 Initial commissioning

The device is adjusted to the situation on site using the SOPAS ET configuration software. To do this, SOPAS ET creates an application-specific parameter set of parameter values. For this purpose, the parameter set can first be loaded from the device (upload, initial commissioning: factory default setting). Or it is created independently, either based on the factory default settings or as a modification of an already existing parameter set of the device of the same type and firmware version.

The parameter set is then loaded into the device (download). This either happens immediately (**Download immediately** option in SOPAS ET) or manually (**Download all parameters to the device** command in SOPAS ET).



NOTE

After completing configuration, the changed parameter set must be permanently stored in the non-volatile memory of the device. As part of a backup concept for the created parameter values, we recommend saving the parameter set as a project file (*.sopas file with configuration data) on the computer for archival purposes.

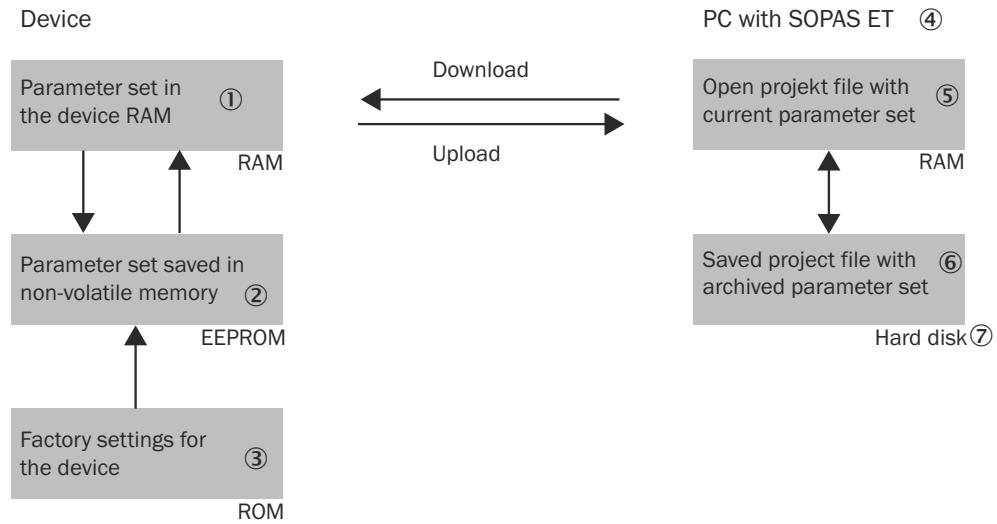


Figure 31: Data storage principle

- ① Parameter set in the working memory of the device
- ② Permanently saved parameter set
- ③ Factory-set pre-settings of the device
- ④ Computer with SOPAS ET
- ⑤ Opened project file with current parameter set
- ⑥ Saved project file with archived parameter set (*.spr)
- ⑦ Hard drive

Device configuration

Interactive configuration with SOPAS ET

All configurable parameters of the device are collected together in a corresponding device description (.sdd file) for SOPAS ET. You can access these parameters via the project tree for the device description.

A content-sensitive explanation of each of the parameters is available directly next to the parameter via the ? button or in the online help (F1 key). The **Parameter Info** display window lists the valid range of values and the default setting (right-click when the pointer is located over the parameter).

**NOTE**

Software access to the device is protected by user levels and passwords. After successfully configuring the device, you should change the passwords so they can fulfill their protective function.

Table 14: Passwords

User levels	Password
Maintenance	main
Authorized Client	client
Service	servicelevel
Operator	-

**NOTE**

Change the passwords during initial commissioning to protect your device.

A higher user level can change the password of a lower user level.

Use the project tree in SOPAS ET to configure the necessary parameters for your application.

**NOTICE****Loss of configuration data in the connected device**

1. Do not switch off the voltage supply during the configuration of the device. Otherwise all parameters not yet saved permanently will be lost.
1. In the **Options** menu, select the **Log into device** command and log in as an **Authorized customer** using the password **client**.
2. Configure the device for the required application using the parameters in SOPAS ET. Help on using the program user interface as well as for the different options can be found in SOPAS ET.

Resetting the configuration**NOTE**

To reset the device to the delivery condition, use the **Factory defaults** option in SOPAS ET.

7.5 Connecting and performing a test measurement

Use the graphic scan view in SOPAS ET to verify the generated measured values and the measuring range online.

1. In the project tree, select **LD-MRS..., Monitor, Evaluation Monitor**.
2. To start the measurement, click on **Display scan line**.
3. Compare the measurement line with the required result.

**NOTE**

- The **Pro scan display** in the **Monitor** depends on the available processing power of the computer and is not a real time display. For this reason not all measured values are displayed. The same restriction also applies to saving the displayed measured values in a file.
- The monitor displays the measured values unfiltered, i.e. the effect of filters cannot be checked using the monitor.

4. After successful completion of the test measurement, save the configuration permanently in the device: Menu LD-MRS, Parameters, Save permanently.

7.6 Synchronization

In a system with a device and an external unit (e.g. a camera), synchronization of the device and the external component is required to minimize time shifts in data collection from both components. This reduces the need for scan data corrections during processing.

During the synchronization process, the device adjusts its scanning frequency (in a small range) so that it performs the measurement at a desired angle to the timing of the synchronization pulse offered by the external unit. Another possibility is that the device acts as a primary device and offers its synchronization pulse to the external unit, which can adjust the frequency at which it performs measurements (e.g. recording images) to this synchronization signal.

To synchronize two or more LD-MRS sensors to perform their measurements simultaneously, their synchronization signals can be networked.

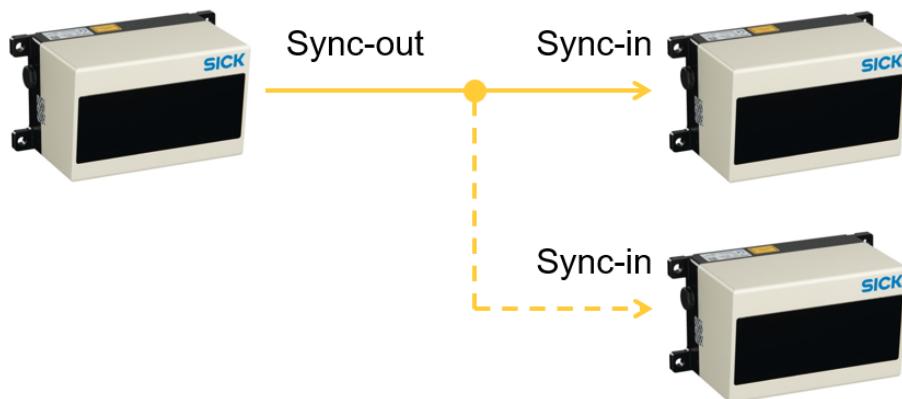


Figure 32: Synchronization with primary and secondary devices



Figure 33: Control of the LD-MRS by the sync signal of the drone computer

7.6.1 Synchronization details



NOTE

The synchronization frequency must be within 8.5 Hz and 50 Hz. Frequencies above or below this will not be accepted by the device.

The measurement accuracy of the synchronization (i.e., the time difference between the synchronization pulse and the crossing of the angle set as SyncAngle) is approximately $\pm 1,000 \mu\text{s}$ for a scanning frequency of 12.5 Hz when there are no external forces acting on the device (especially no angular acceleration). This is equivalent to an angular accuracy of $\pm 4.5^\circ$ around the true 0° direction.

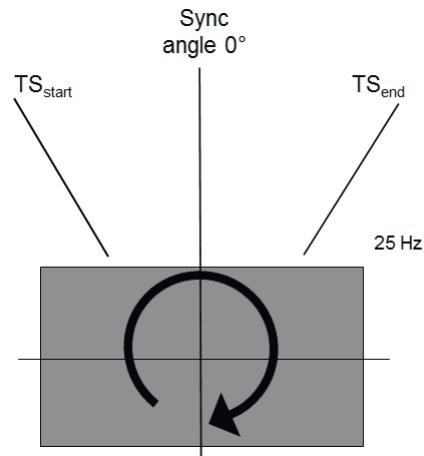


Figure 34: Synchronization details

For the scanning frequency of 25 Hz and 50 Hz, the accuracy is $\pm 500 \mu\text{s}$, which is equivalent to an angular accuracy of $\pm 4.5^\circ$ and $\pm 9^\circ$, respectively. The external synchronization frequency f_{sync} can be selected in a range of $8.5 \text{ Hz} \leq f_{sync} \leq 50 \text{ Hz}$ and should have a relative accuracy better than 0.1% (the better the f_{sync} , the better the synchronization of the device).

It is therefore not recommended to send the synchronization signal from a computer, because its timers are usually not very accurate. Instead, a dedicated microcontroller should be used to generate the synchronization signal. The external synchronization frequency and the scanning frequency do not have to match. The external synchronization frequency must be within $\pm 4 \text{ Hz}$ of scanning frequency f_{scan} ($f_{sync} = f_{scan} \pm 4 \text{ Hz}$). The device adjusts the scanning frequency to the external synchronization frequency. If the external synchronization frequency fails, the device will readjust its scanning frequency to the originally set value.

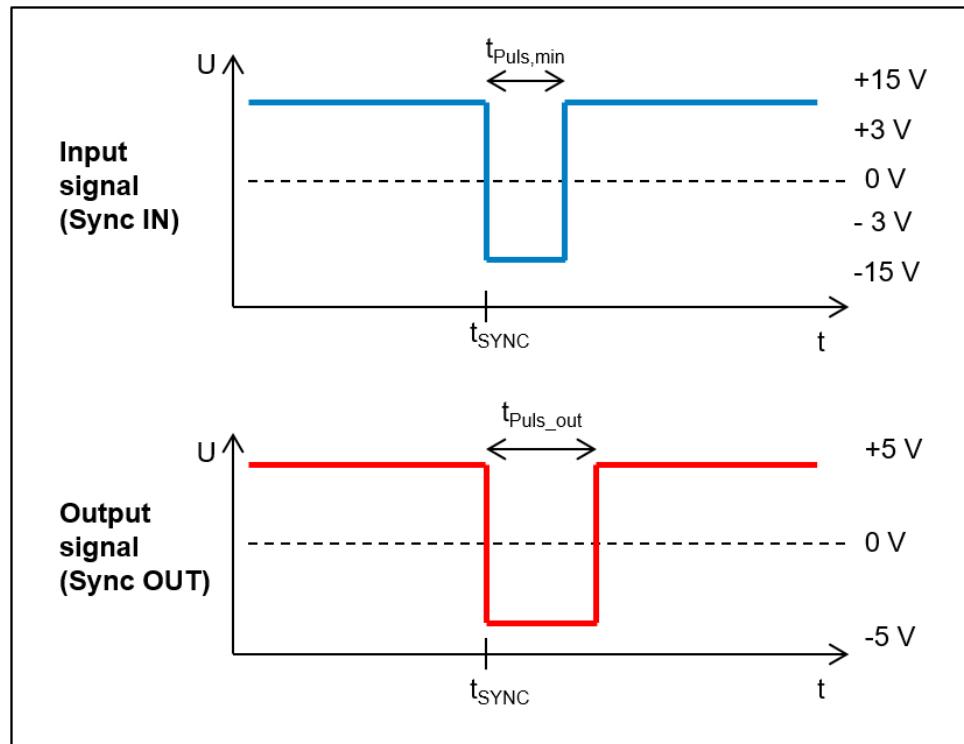


Figure 35: Sync IN pulse and Sync Out pulse

The voltage level for detecting an external trigger signal must have the I/O-232 level (formerly RS-232). The device detects a logical positive signal edge as the moment to synchronize, see $T_{SyncTime}$ in [figure 35](#).

7.6.2 Synchronization systems

There are three possible synchronization systems:

- Device and external unit synchronized by the device
- Device and external unit that synchronizes the device
- Device and two external units, one of which synchronizes the device and the other is synchronized by the device
- The external unit can also be another device.

Each device starts as a primary unit that sends trigger pulses to the next unit. The device always sets the output signal for $t_{Puls_out} = 20 \mu s$, see red output signal in [figure 35](#).

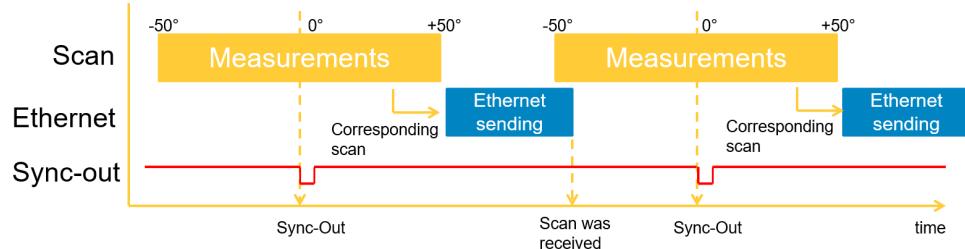
When a transition from low to high is received at the trigger input, the device switches to secondary mode; this stops further active transmission of the Sync pulse. It now only copies and transmits the trigger of the primary device.

The external synchronization pulse signal should remain in the high state for at least $t_{pulse,min} = 10 \mu s$, see blue input signal in [figure 35](#). Without external trigger, the device will switch back to primary mode after approx. 300 ms.

7.6.3 Hardware-based synchronization

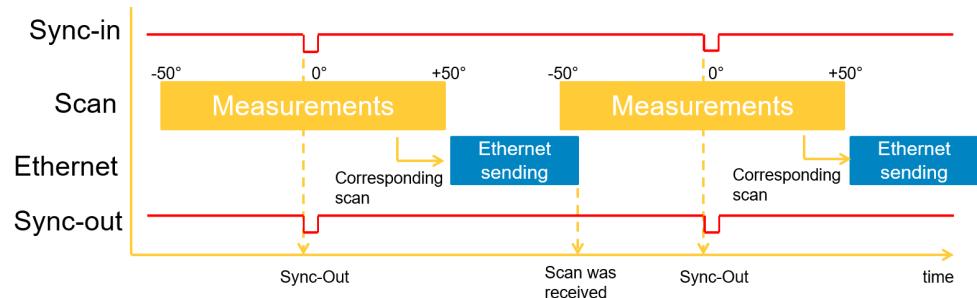
Sync-out

The device has a bit output called "Sync-Out". This output has a high-to-low transition each time the 0° measurement is taken. The user system must scan the Sync-Out signal with the required accuracy. The next scan on the Ethernet interface is the one to which this Sync-Out signal belongs.



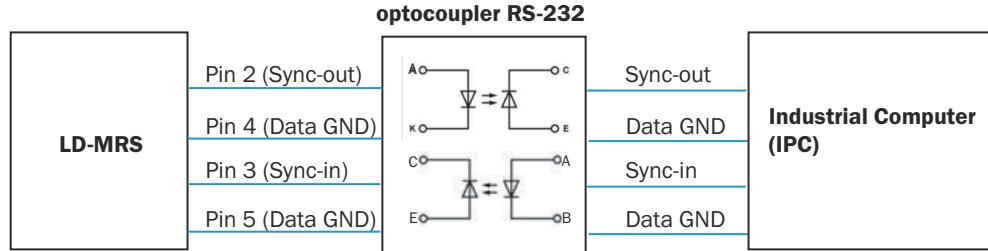
Sync-In

The device has a bit output called "Sync-Out". This output has a high-to-low transition each time the 0° measurement is taken. The user system must scan the Sync-Out signal with the required accuracy. The next scan on the Ethernet interface is the one to which this Sync-Out signal belongs.



7.6.3.1 Optocoupler RS-232

To avoid possible differences between the device and a host computer, an optocoupler RS-232 is recommended.

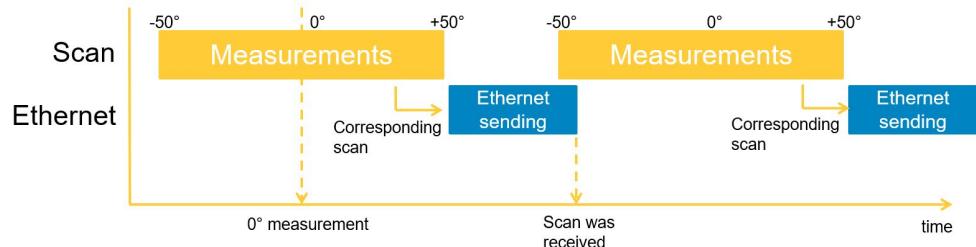


The maximum length of cable for the RS-232 is 15 m. For longer distances, isolated converters for RS-422 or RS-485 are recommended.

7.6.4 Software-based synchronization

Time control via Ethernet

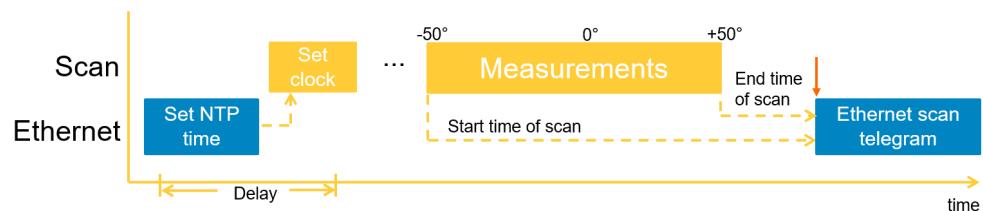
Since Ethernet is not a real-time interface, the timing may vary. However, if both the interface and the processing system (host) are not operating at the limit, the timing is usually relatively stable. Interface timing depends on many factors, including interface utilization, device firmware versions, and number of scan points. Since the device only transmits valid scan points, scans with few scan points are transmitted faster than full scans. The typical accuracy of the synchronization is in the ms range.



NTP time stamp

An NTP time can be set in the device with the commands `SetNTPTimestampSec` and `SetNTPTimestampFracSec`. A sample project (C++ code for Linux) is available for setting the NTP time.

Each scan telegram contains the start and end time of the scan in NTP format. Due to the inaccuracy of the command time, there is a timing error. The typical accuracy of the synchronization is in the ms range.



7.7 ROS driver

Suitable drivers for integrating the device into the ROS (Robot Operating System) are available for download on the product page.

The page can be accessed via the [SICK Product ID: pid.sick.com/{P/N}/{S/N}](http://pid.sick.com/{P/N}/{S/N})

{P/N} corresponds to the part number of the product, see type label.

{S/N} corresponds to the serial number of the product, see type label (if indicated).

8 Maintenance

8.1 Maintenance plan

During operation, the device works maintenance-free.

NOTE

No maintenance is required to ensure compliance with the laser class.

Depending on the assignment location, the following preventive maintenance tasks may be required for the device at regular intervals:

Table 15: Maintenance plan

Maintenance work	Interval	To be carried out by
Check device and connecting cables for damage at regular intervals.	Depends on ambient conditions and climate.	Specialist
Clean housing and viewing window.	Depends on ambient conditions and climate.	Specialist
Check the screw connections and plug connectors.	Depends on the place of use, ambient conditions or operating requirements. Recommended: At least every 6 months.	Specialist
Check the mounting accessories and vibration dampers used.	Depends on the place of use, ambient conditions or operating requirements. Recommended: At least every 6 months.	Specialist
Check that all unused connections are sealed with protective caps.	Depends on ambient conditions and climate. Recommended: At least every 6 months.	Specialist

8.2 Cleaning

**NOTICE****Equipment damage due to improper cleaning.**

Improper cleaning may result in equipment damage.

- Only use recommended cleaning agents and tools.
 - Never use sharp objects for cleaning.
-

Cleaning the viewing window

Check the viewing window of the device for accumulated dirt at regular intervals. This is especially important in harsh operating environments (dust, abrasion, damp, fingerprints, etc.).

The viewing window lens must be kept clean and dry during operation.

**NOTE**

Static charging may cause dust particles to stick to the viewing window. This effect can be avoided by using an anti-static cleaning agent in combination with the SICK lens cloth.

Cleaning procedure:**CAUTION****Optical radiation: Class 1 Laser Product**

The accessible radiation does not pose a danger when viewed directly for up to 100 seconds. It may pose a danger to the eyes and skin in the event of incorrect use.

- Do not open the housing. Opening the housing may increase the level of risk.
- Current national regulations regarding laser protection must be observed.

- ▶ Switch off the device for the duration of the cleaning operation. If this is not possible, use suitable laser protection goggles. These must absorb radiation of the device's wavelength effectively.
- ▶ Clean the viewing window only with a clean, damp, lint-free cloth, and a mild anti-static lens cleaning fluid.

**NOTICE**

If the inspection window is scratched or damaged (cracked or broken), the lens must be replaced. Contact SICK Support to arrange this.

- If the inspection window is cracked or broken, take the device out of operation immediately for safety reasons and have it repaired by SICK.

9 Troubleshooting

9.1 General faults, warnings, and errors

Possible faults and corrective actions are described in the table below for troubleshooting. For faults that cannot be rectified using the information below, please contact SICK Service. To find your agency, see the final page of this document.

NOTE

Before calling, make a note of all type label data such as type designation, serial number, etc., to ensure faster assistance.

NOTE

When an error occurs in the device, it outputs corresponding warning and error messages via the Ethernet interface. The user has the option of extracting the warning and error messages from the Ethernet data stream.

If the **SICK LaserView Customer Edition** is used to visualize the scan data, the errors are displayed there. For this purpose, see the **SICK LaserView Customer Edition Visualization Tool** operating instructions (part no. 8013786), section **Trace log** and the **Ethernet data protocol** (part no. 8014492) and **CAN data protocol** (part no. 8014493) telegram listings.

The warning and error messages contain bit fields, each bit of which represents a warning or an error. Two times 16 bits each are available for warnings and errors.

Table 16: Troubleshooting questions and replies

Question / status	Response / remedial actions
SOPAS ET cannot communicate with the device. 	<p>NOTE For S01 devices and for LD-MRS420201 (part no. 1085081), SOPAS ET can only be used to change the IP address.</p>
	<p>Supply voltage not switched on</p> <ul style="list-style-type: none"> • Check the supply voltage. • Check whether supply cables are fixed correctly in the connector plug. • Check whether the cables are poled correctly. • Increase the conductor cross section. • Disconnect the supply voltage and reconnect. If the red LED is still lit, inform SICK Service. • Check the supply voltage. • Check whether supply cables are fixed correctly in the connector plug. • Check whether the cables are poled correctly. • Increase the conductor cross section. • Disconnect the supply voltage and reconnect. If the red LED is still lit, inform SICK Service.
	<p>Computer not connected</p> <ul style="list-style-type: none"> • Connect the computer to the device (use a suitable data cable for the type of interface).
	<p>Incorrect interface selected</p> <ul style="list-style-type: none"> • Select the interface in SOPAS ET according to the connection made on the computer.
	<p>Another application on the computer is already accessing the interface</p> <ul style="list-style-type: none"> • Check the assignment of the interface; if necessary end the application accessing the interface.
	<p>Sequence not observed when switching on the device</p> <ol style="list-style-type: none"> 1. Switch on the computer. 2. Connect the computer to the device. 3. Switch on the device.
Computer with SICK LaserView Customer Edition cannot communicate with the device.	<ul style="list-style-type: none"> • Check supply voltage, switch on. • Connect computer to Ethernet interface of the device.
Measuring operation: No scan data.	<ul style="list-style-type: none"> • Mount the device in a more favorable position or realign it (observe field of view and angle of rotation). • Parameterize device correctly.
Field application: No signaling of occurring object detections	<ul style="list-style-type: none"> • In SOPAS ET: Check evaluation case and parameterize correctly if necessary. • In SOPAS ET: Check CAN parameterization. Check configuration of external outputs. • Check wiring between device and optional CAN module.

9.2 Repairs

Repair work on the device may only be performed by qualified and authorized personnel from SICK AG. Interruptions or modifications to the device by the customer will invalidate any warranty claims against SICK AG.

9.3 Returns

- ▶ Only send in devices after consulting with SICK Service.
 - ▶ The device must be sent in the original packaging or an equivalent padded packaging.
-



NOTE

To enable efficient processing and allow us to determine the cause quickly, please include the following when making a return:

- Details of the contact person
 - Description of the application
 - Description of the fault that occurred
-

9.4 Disposal

If a device can no longer be used, dispose of it in an environmentally friendly manner in accordance with the applicable country-specific waste disposal regulations. Do not dispose of the product along with household waste.



NOTICE

Danger to the environment due to improper disposal of the device.

Disposing of devices improperly may cause damage to the environment.

Therefore, observe the following information:

- Always observe the national regulations on environmental protection.
 - Separate the recyclable materials by type and place them in recycling containers.
-

10 Technical data



NOTE

The relevant online product page for your product, including technical data, dimensional drawing, and connection diagrams, can be downloaded, saved, and printed from the Internet.

The page can be accessed via the **SICK Product ID: pid.sick.com/{P/N}/{S/N}**

{P/N} corresponds to the part number of the product, see type label.

{S/N} corresponds to the serial number of the product, see type label (if indicated).

Please note: This documentation may contain further technical data.

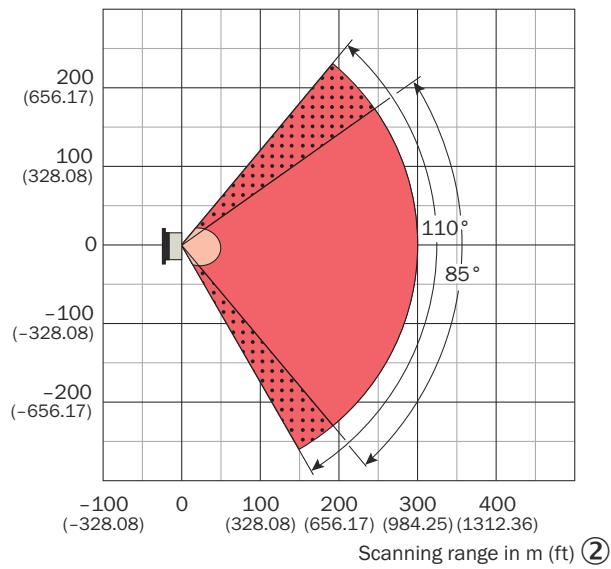
10.1 Features

	LD-MRS4xx	LD MRS8xx
Application	Outdoor	
Light source	Infrared (905 nm, maximum output power 110 W, pulse duration 5 ns)	
Laser class	Laser class 1 (EN/IEC 60825-1:2014) Complies with 21 CFR 1040.10 and 1040.11 except for the listed tolerances in the document "Laser Notice No. 50", dated June 24, 2007.	
Working range	0.3 ... 30 m at 10% remission (LD-MRS400102) 0.3 ... 50 m at 10% remission (LD-MRS400001, LD-MRS420201)	0.3 ... 30 m at 10% remission (LD-MRS820301) 0.3 ... 50 m at 10% remission (LD-MRS800001)
Horizontal aperture angle	4 scan planes: 85° + 2 scan layers: 110°; areas overlap	8 scan planes: 85° + 4 scan layers: 110°; areas overlap
Scan planes	4, vertical aperture angle over 4 scan planes: 3.2°	8, vertical aperture angle over 8 scan planes: 5.6° ±0.2° 4.2° (±0.2°) at 50° scanning angle 5.6° (±0.2°) at 0° scanning angle 6.4° (±0.2°) at -50° scanning angle
Scanning frequency	Measuring operation: <ul style="list-style-type: none">• 12.5 Hz (0.125 ... 0.5°)• 12.5 Hz (0.25°)• 25 Hz (0.25°)• 50 Hz (0.5°) Tracking (part no. 105260, 1052961 and 108081 only): <ul style="list-style-type: none">• 12.5 Hz (0.25°) Field application (part no. 1045046, 1047145 only): <ul style="list-style-type: none">• 12.5 Hz (0.25°)• 25 Hz (0.25°)• 50 Hz (0.5°)	Measuring operation: <ul style="list-style-type: none">• 12.5 Hz (0.125 ... 0.5°)• 12.5 Hz (0.25°)• 25 Hz (0.25°)• 50 Hz (0.5°) Tracking (LD-MRS800xxx only): <ul style="list-style-type: none">• 12.5 Hz (0.25°)• Focused (0.125 ... 0.5°)• Flexible resolution (0.125 ... 0.5°)
Angular resolution	Min. 0.125° (interlaced)/0.25°/0.5°	
Beam divergence	Horizontal 0.08°, vertical 0.8° per scan plane, per laser 1.6°	

	LD-MRS4xx	LD MRS8xx
Echoes per single measurement (echo)	3 2 (LD-MRS820301)	

Working range diagram

Scanning range in m (ft) ①



Scanning range in m (ft) ②

- Scanning range max. 300 m (984.25 ft) ③
- Scanning range for objects up to 10 % remission 50 m (164.04 ft) ④
- 2 scan layers ⑤
- 4 scan layers ⑥

Figure 36: LD-MRS working range, dimensions in mm (inch), decimal separator: period

- ① Scanning range in mm
- ② Scanning range in mm
- ③ Scanning range max. 300 m
- ④ Scanning range for objects up to 10% remission 50 m
- ⑤ 2 scan planes
- ⑥ 4 scan planes

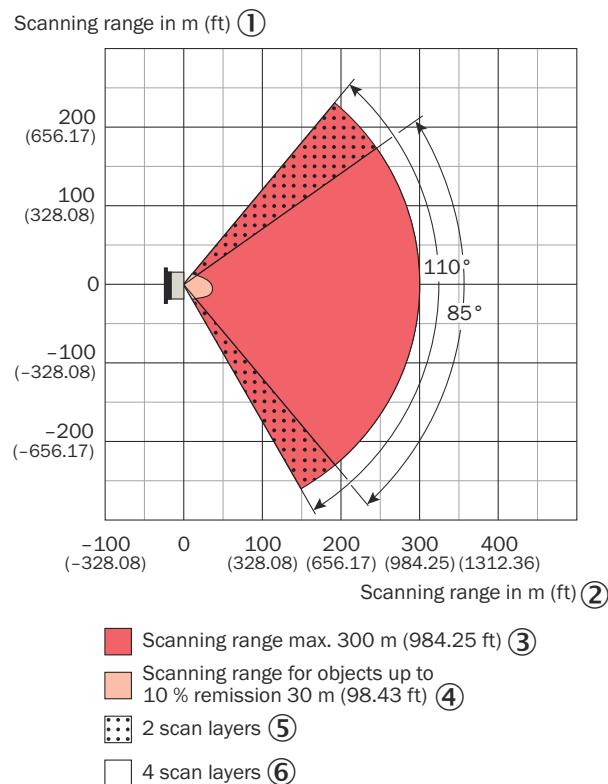


Figure 37: LD-MRS HD working range, dimensions in mm (inch), decimal separator: period

- ① Scanning range in mm
- ② Scanning range in mm
- ③ Scanning range max. 300 m
- ④ Scanning range for objects up to 10% remission 50 m
- ⑤ 2 scan planes
- ⑥ 4 scan planes

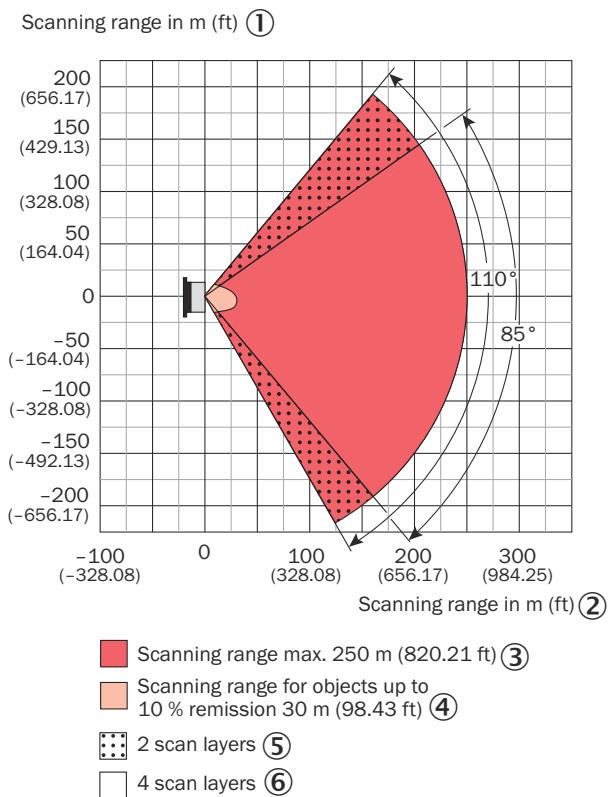


Figure 38: LD-MRS400102 HD working range, dimensions in mm (inch), decimal separator: period

- ① Scanning range in m
- ② Scanning range in m
- ③ Scanning range max. 300 m
- ④ Scanning range for objects up to 10% remission 50 m
- ⑤ 2 scan planes
- ⑥ 4 scan planes

10.2 Mechanics/Electronics

	LD-MRS40xxxx LD MRS80xxxx	LD MRS42xxxx LD MRS82xxxx
Electrical connection	3x round connector	
Supply voltage	DC 9 ... 30 V, typical 12 V / 24 V, reverse polarity protected	
Power-up time until ready for operation	15 s (at ambient operating temperature 20 °C)	
Power consumption	Max. 10 W, typical 8 W, briefly 36 W at system start-up	
Housing	Aluminum Viewing window: Computer	
Housing color	Gray (RAL 7042), black (RAL 9005) ¹⁾ , gray (RAL 7032) ¹⁾	
Enclosure rating	IP69k, male connector IP68 (2 m / 24 h) according to DIN 40 050 / EN 60529 (1991-10) + A1:2000-02	
Protection class	III (IEC 61140:2002-03)	
Electrical safety	According to EN 61010-1:2010-10 / EN 61010-1 / A1:2019-02	
Weight	Approx. 1 kg	Approx. 0.77 kg

	LD-MRS40xxxx LD MRS80xxxx	LD MRS42xxxx LD MRS82xxxx
Dimensions (L x W x H)	88 mm x 164.5 mm x 93.2 mm including mounting straps	88 mm x 164.5 mm x 91.3 mm including mounting straps

1) LD-MRS820301 only available in gray (RAL 7042)

10.3 Dimensional drawing

LD-MRS40xxxx

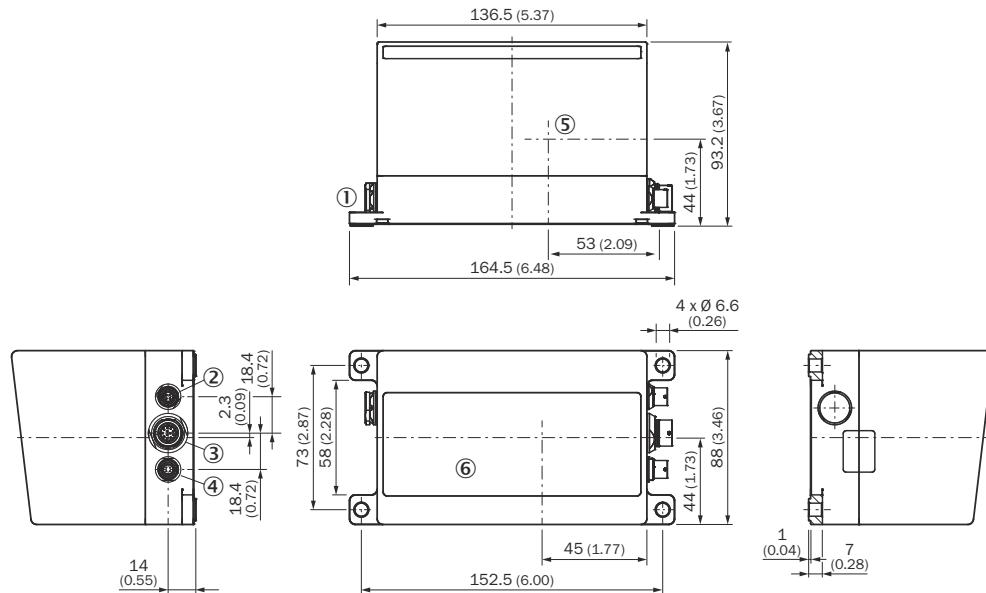


Figure 39: LD-MRS40xxxx device dimensions, dimensions in mm (inch), decimal separator: period

- ① Ventilation valve
- ② Ethernet connection, 4-pin round socket
- ③ Data interface/synchronization connection, 12-pin round socket
- ④ Voltage supply connection, 4-pin round socket
- ⑤ Sensor coordinate origin
- ⑥ Viewing window

LD-MRS42xxxx and LD-MRS82xxxx

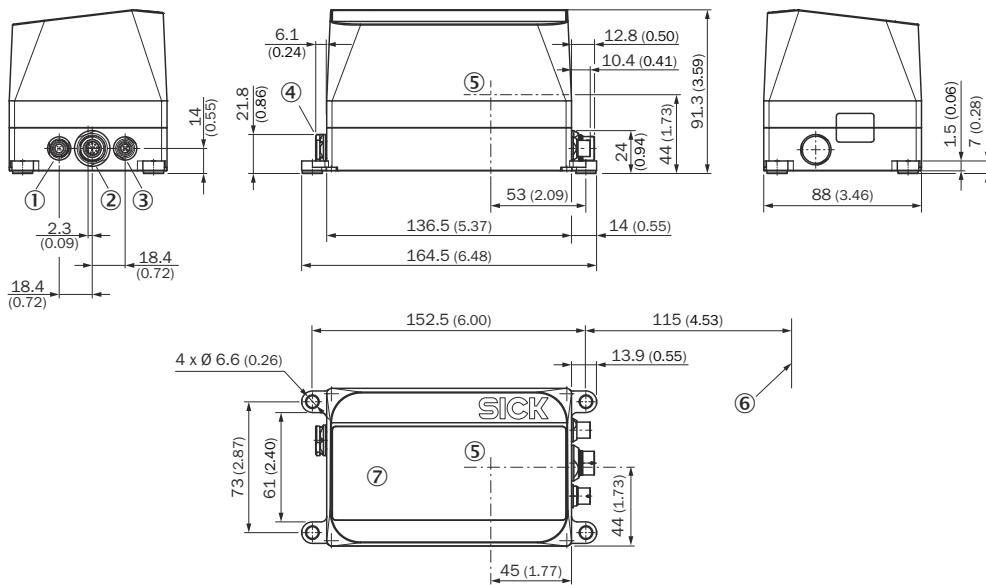


Figure 40: LD-MRS42xxxx and LD-MRS82xxxx device dimensions, dimensions in mm (inch), decimal separator: period

- ① Ventilation valve
- ② Ethernet connection, 4-pin round socket
- ③ Data interface/synchronization connection, 12-pin round socket
- ④ Voltage supply connection, 4-pin round socket
- ⑤ Sensor coordinate origin
- ⑥ Minimum area to be kept clear for the connecting cable (at least 72 mm with bend radius)
- ⑦ Viewing window

10.4 Performance

Detectable object shape	Almost any
Systematic error	±300 mm ¹⁾
Statistical error	100 mm ¹⁾
Integrated application	Object tracking (part no. 105260, 1052961, 108081 and 1069408) Field evaluation (part no. 1045046, 1047145) Measurement data output

¹⁾ Typical value; actual value depends on ambient conditions

10.5 Interfaces

	LD-MRS40xxxx	LD MRS42xxxx LD MRS8xxxxx
Ethernet	TCP/ IP Full duplex Raw data interface/Parameterization Data transmission rate: 100 Mbit/s	
CAN	500 KBit/s (fixed) Output: Object output, input: Proper motion of the vehicle Addressing range 0 ... 127 Length of cable max. 100 m	

	LD-MRS40xxxx	LD MRS42xxxx LD MRS8xxxx
Serial	RS-232 Auxiliary interface Data transmission rate: 57600 baud Data format: Variable, default: 8 data bits, 1 stop bit, no parity Protocol: CoLa-A	
Optical displays	-	
Digital outputs	Measuring operation: No field application: 2 inputs/10 outputs (external implementation via max. 2 optional CAN modules with 8 configurable I/O ports each)	-
Configuration software	Measuring operation: With SICK LaserView Customer Edition Visualization Tool or telegrams Field application: With SOPAS-ET configuration software	

10.6 Ambient data

	LD-MRS40xxxx LD MRS80xxxx	LD MRS42xxxx LD MRS82xxxx
Electromagnetic compatibility (EMC)	Radiated emission: in accordance with EN 61000-6-3 (2007-01) Immunity: in accordance with EN 61000-6-2 (2005-08)	
Vibration resistance	Vibrations, sinusoidal according to EN 60068-2-6 (1995-04) Broadband noise vibrations (digitally controlled) and guiding paths according to EN 60068-2-64 (1994-06)	
Shock resistance	Continuous shock EN 60068-2-29 (1993-04)	Continuous shock EN 60068-2-27
Ambient operating temperature	-40 °C ... +70 °C	
Storage temperature	-40 °C ... +95 °C	
Operating and storage air humidity	Max. 85% relative humidity (non-condensing)	
Ambient light immunity	100 klx	

11 Accessories



NOTE

On the product page you will find accessories and, if applicable, related installation information for your product.

The page can be accessed via the **SICK Product ID: pid.sick.com/{P/N}/{S/N}**

{P/N} corresponds to the part number of the product, see type label.

{S/N} corresponds to the serial number of the product, see type label (if indicated).

Support Portal



NOTE

In the SICK Support Portal (supportportal.sick.com, registration required) you will find, besides useful service and support information for your product, further detailed information on the available accessories and their use.

12 Annex

12.1 Declarations of conformity and certificates

You can download declarations of conformity and certificates via the product page.

The page can be accessed via the **SICK Product ID: pid.sick.com/{P/N}/{S/N}**

{P/N} corresponds to the part number of the product, see type label.

{S/N} corresponds to the serial number of the product, see type label (if indicated).

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